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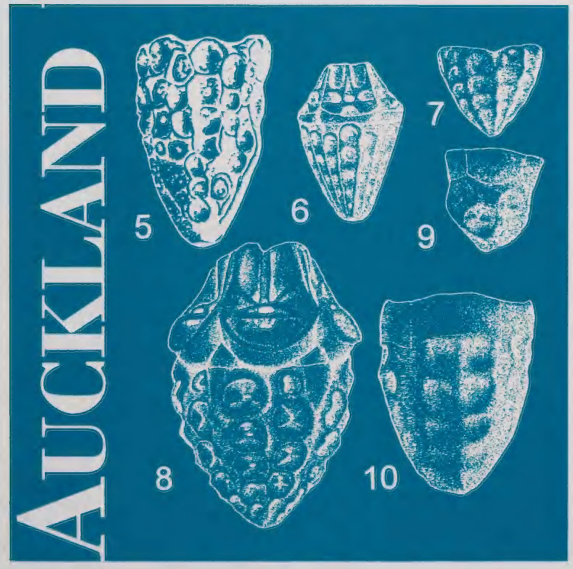

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Te Papa Whakahiku

RECORDS

of the

AUCKLAND MUSEUM

Volumes 37 and 38

AUCKLAND, NEW ZEALAND

2001

ISSN 1174-9202
RECORDS OF THE AUCKLAND MUSEUM
Vols 37 & 38

Published by Order of the Trust Board
T.L.R. WILSON, Director

[Vol. 36 for 1999 was published on 21 August 2000]

Editors
B.J. GILL and N.J. PRICKETT

The Auckland War Memorial Museum has a statutory role to advance and promote cultural and scientific scholarship and research, that is met in part by publication of the *Records of the Auckland Museum* (formerly *Records of the Auckland Institute and Museum*). The *Records* has been published continuously since 1930 and issues now appear once annually. Vol. 34 contained indexes to the contents of vols 1-33. Monographs are produced occasionally in the series *Bulletin of the Auckland Museum* (see list of titles at end of this volume).

The *Records* contain the results of original research dealing with material in the collections of Auckland Museum, and research carried out by museum staff members in their particular subjects. All papers are refereed. Instructions for authors are given at the end of this volume. The *Records* are distributed, largely by exchange, to libraries at nearly 300 academic institutions throughout the world. Proposals for exchange agreements should be addressed to the Auckland Museum Librarian.

The contents of the *Records* are reported in *Biological Abstracts*, *Zoological Record* and *GeoRef* (American Geological Institute).

In this issue, volumes 37 and 38 are printed together to catch up on past production delays. We intend to resume with one volume per year for the next issue.

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FROM CANOE TO CHURCH ON LATE NINETEENTH CENTURY ULAWA, SOLOMON ISLANDS

ROGER NEICH

Abstract. This study surveys the published literature on Ulawa bonito canoes to provide a context for the description of a shell-inlaid bonito canoe from Ulawa purchased by Auckland Museum in 1897. The symbolism of the canoe's shell inlay is explained on the basis of a contemporary letter written by Rev. Walter Ivens of the Melanesian Mission, leading to an understanding of the place of bonito fishing in Ulawan culture. Built by the people of Madoa village under the direction of Rev. Clement Marau, the canoe was sold to raise money for a corrugated iron roof on the Madoa Church then under construction. Contemporary accounts of the building of the Madoa Church provide an insight into the role of the Melanesian Mission in the conversion of Ulawa to Christianity and the commodification of Ulawan material culture. These records demonstrate the development of tourist art, especially model canoes and inlaid bowls, on Ulawa in the later decades of the nineteenth century. Questions of authenticity are discussed with regard to the role of the Melanesian Mission and its staff in the production of this bonito canoe and Ulawan tourist art.

KEYWORDS: Bonito canoe; shell inlay; Christianity; Melanesian Mission; Ulawa; Solomon Islands.

INTRODUCTION

Among the extensive Pacific artefact collections in the Auckland Museum, a beautiful small bonito-fishing canoe from Madoa village on Ulawa in the Solomon Islands survives as mute evidence of changing times in turn-of-the-century Melanesia. This canoe is a product of those few years at the end of the nineteenth century when the process of conversion to Christianity on Ulawa was at its most intense. Another product of those years is the large church built at Madoa on Ulawa under the direction of the Rev. Clement Marau, a Melanesian Mission clergyman. The canoe and church are connected through the aspirations and activities of Clement Marau and his converts.

This is also the period when much of the original fieldwork and language learning was being carried out by those missionaries such as Codrington, Fox and Ivens who later wrote the major ethnographies on which our knowledge of south-eastern Solomon Islands cultures are based. By their time, these cultures had already been drastically altered by European administrative, trading and missionary activities.

Apart from this Auckland Museum canoe, very few nineteenth century Ulawa canoes are now left in the world, perhaps only the one in the British Museum (Haddon 1937:94; Mendana 1901:xxii) and another in the Maidstone Museum, Kent, England (Waite 1987:52). The Maidstone Museum canoe is a *lisi* type of larger canoe made for inter-island travel, not a bonito

canoe. The British Museum canoe (registration number 1870.2-9.1) is a three or four-man bonito canoe. Consequently, this Auckland Museum bonito canoe is extremely important as a rare surviving example of a vanished craft for which the island of Ulawa was famous. Beyond its intrinsic importance as a historical artefact, this canoe is also an instructive example of the way objects pass through times and retain the social imprints of their passing.

Since the publication of studies on colonial change in ethnic arts such as Graburn's *Ethnic and Tourist Arts of the Fourth World* (1976) and Thomas's *Entangled Objects* (1991), we have come to realise the greater time depth and the intensity of colonial intermeshing which has produced the artefacts collected through much of the nineteenth century. As Graburn (1999:345) has bluntly stated:

> We now realize that practically all the objects in our ethnographic collections were acquired in politically complex, multicultural colonial situations. Furthermore, we can state unequivocally that unless we include the sociopolitical context of production and exchange in our analyses we will have failed in our interpretation and understanding.

For some purists, this situation of colonial complexity has called into question the authenticity of the artefacts produced under these conditions. However, as Graburn (1999:350 ff.) has made clear:

> Authenticity and genuineness were folk categories, measures by which people in certain historical or cultural situations judged cultural productions.

Authenticity as a culturally constructed concept has important meanings for the consumers and, at least in the early stages of cross-cultural contact, it has little meaning for the producers. Judgements of authenticity have served as a device for maintaining power and stratification in colonial systems. But now, many indigenous groups have taken up the discourse of authenticity to enhance their positive self-image and to recover pride in their native identity.

When champions of the so-called 'authentic artefact' imply that artefacts made in these intercultural situations are therefore non-authentic, it is beholden upon the art-historical analyst to realise and demonstrate that:

> ... the solution to defining the authenticity of an object circulating in the network of world art exchange lies not in the properties of the object itself but in the very process of collection, which inscribes, at the moment of acquisition, the character and qualities that are associated with the object in both individual and collective memories. In order to interpret such objects we must begin to unpack the baggage of transcultural encounter with which they travel and search for the meanings and memories stored inside. (Phillips and Steiner 1999:19)

This analysis will reveal ramifications throughout Ulawan culture at a time of drastic change. The circumstances surrounding the construction and sale of this canoe and the building of the Madoa church constitute a particularly clear example of this cross-cultural engagement. It becomes a study of both indigenous and missionary attitudes towards the old culture and the new missionized culture.

Fortunately, the Melanesian Mission and its supporters constantly felt the need to report their experiences, in published books and especially in the mission's periodical, the *Southern Cross Log* (Note 1). With such a wealth of documentation and contemporary photographs

(Note 2) available, a closer examination of this story allows a detailed reconstruction of the context for these events. Thanks to the records contained in contemporary missionary and indigenous accounts of the action, the story can be told largely through the actual words of the participants or key observers, thereby revealing their attitudes with exceptional clarity.

The analysis also traces the introduction and development of new techniques and skills in artefactual competence; the Madoa canoe and church are both the result of an amalgam of Solomon Islands and English skills. The canoe was made with introduced metal tools, applied with traditional skills in an acculturated situation, with the direct intention of sale outside the culture of its makers. On the other hand, the church was built with introduced tools, applied with newly-learned skills in an acculturated situation, with the intention of producing a highly-valued object for use within the culture of its makers. Both the canoe and the church are therefore perfect examples of objects embedded in their times, supremely 'entangled objects', each with a social history all its own.

BONITO CANOES OF ULAWA

Labillardiere in June 1793 off the island of Ulawa was probably the first European to record a detailed description of Ulawan canoes. While still some distance offshore from Ulawa (Fig. 1), a four-man canoe paddled out to the French ship and was soon joined by eight other canoes eager to trade. Labillardiere wrote:

> We admired the elegant form of their canoes, which were exactly similar to those we had seen the preceding days at the easterly part of the Arsacides [Malaita]. They were about twenty-one feet in length, two in breadth, and fifteen inches in depth. The bottom consisted of a single piece cut from the trunk of a tree, and the sides were formed

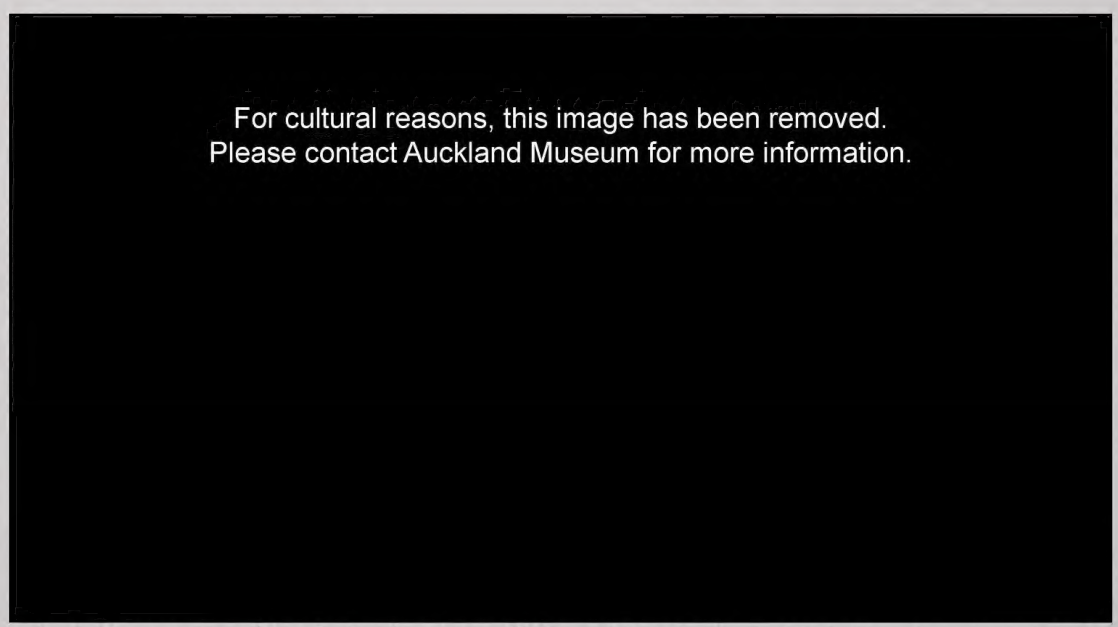

Fig. 1. Canoes approaching the *Southern Cross* off Ulawa, Solomon Islands, 1906. Photo: Beattie, Auckland Museum.

> of a plank, the whole length of the boat, supported by beams fixed at equal distances into the bottom: at both ends other planks were attached to the first. These were ornamented on the outside with figures of birds, fishes, and &c., rudely carved. The greater part of the canoes were terminated in front with the head of a bird, under which was seen a large bunch of fringe, coloured with a red dye, which appeared to me to have been made of the leaves of the vacoua. The other extremity of the boat was likewise ornamented with a red fringe, and here we frequently observed, in the inner side, the carving of a dog projecting from the vessel, which led me to suppose that the savages possess this animal. I was surprised to observe that they had given it nearly the form of a blood-hound; though it is probable that they do not possess that species, but that the carving was nothing more than an imperfect representation of the dog usually met with in the South Sea islands. (Labillardiere 1800:277-2788)

Labillardiere commented on the instability of these canoes in the waves and their need for constant bailing but was amazed at the speed they attained when paddled with full effort. Labillardiere's description and his plate suggest that these were probably large four-man versions of bonito canoes.

When Brenchley (1873:249) arrived off Ulawa on HMS *Curacoa* in 1865, he counted at least 90 canoes coming out to meet them. Judging from his description these were also bonito canoes:

> ...their two ends were alike, they were without outriggers, and generally carried two, rarely three men; their paddles were short, narrow, with a pointed blade. At each extremity the canoes were ornamented with tassels, made of strips of pandanus leaf dyed red at intervals, and also with mother-of-pearl let in different patterns.

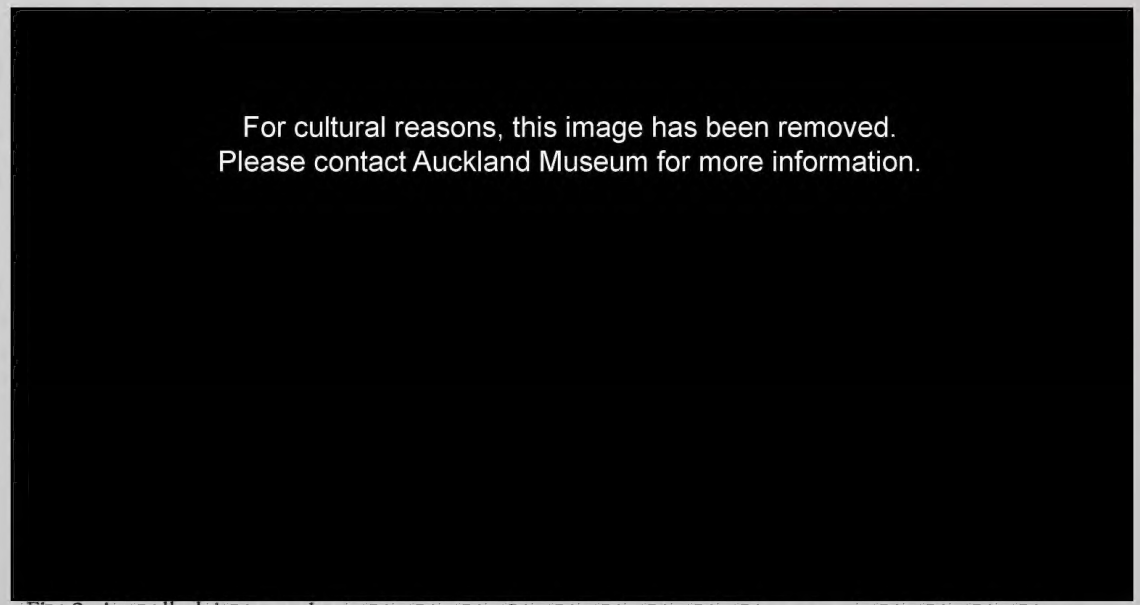

Fig. 2. A small plain general purpose canoe and young non-Christian men at canoe landing place, Ahia, Ulawa, 1906. Photo: Beattie, Auckland Museum.

These excellent descriptions from 1793 and 1865 demonstrate that Ulawa bonito canoes do not seem to have changed appreciably over the ensuing 100 years between Labillardiere and the missionary descriptions from the 1890s. The only major difference is that perhaps the larger three and four-man bonito canoes had become less frequent in favour of two-man versions (Fig. 2).

Former missionary the Rev. Walter Ivens (1927:149-154) has provided the most detailed account of the building of canoes on Ulawa, where the generic term for canoe is *iola*. However, his account is still somewhat sketchy with regard to the bonito canoe, dealing mostly with the larger inter-island canoes. Of these larger canoes, Ivens mentions the *raku* which holds six men, the *lisi nima* which is the ordinary overseas canoe, the *la'o* which is a *lisi* decorated with coneshell *la'o* inlays, and the *iola sara'a* which had two projections on the prow, a mast decorated with cowries in the bows and a narrow stern with carvings of two birds and a man. The *iola sara'a* had become obsolete long before Ivens's time. Haddon (1937:91-95) largely followed Ivens for his description of Ulawa canoes, and uses Ivens's general term *iola*, to apply specifically to the bonito canoe.

Without giving a specific Ulawan term for bonito canoes in this text, Ivens describes them as a three or four-man canoe, up to 24 feet long, about 28 inches wide and 14 inches deep on the outside. All bonito canoes have an individual name. The future owner cuts and prepares the necessary timber, then engages an expert canoe builder who must be paid and fed. For an inlaid and decorated bonito canoe, the builder could be paid up to ten pieces of shell money. In his dictionary of the Ulawa language, Ivens (1929:130) gives the term *iola ni weieu* for bonito canoe, which simply means "canoe for bonito". He goes on to list specific terms for other types of canoes, namely a canoe without separate attached stem and stern, a one-man canoe, a three-man canoe, a four-man canoe, a six-man canoe, and the two types of larger overseas canoes described above.

It should be noted that the Auckland Museum Ulawa canoe does not have a carved dog at the stern although some writers (reviewed below) have given the impression that this carving is a universal feature of south-east Solomons bonito canoes. Labillardiere off Ulawa in June 1793 carefully described a carving of a dog on the stern of several canoes. However, in his description cited above, Labillardiere says, "we frequently observed", which implies that a dog carving was not present on all of the canoes seen at that time.

In 1851 while travelling through the Solomon Islands in his yacht *Wanderer,* John Webster painted a bonito canoe at the entrance to Marau Sound, Guadalcanal (Auckland Museum PD 43.19). This shows an animal carving at the stern, probably a bird rather than a dog judging by its round head without ears and straight non-curled tail. Another Webster sketch of a bonito canoe stern (Auckland Museum PD 43.27) clearly shows a small carving of a dog with ears and curled tail. Webster's admiring description of San Cristobal bonito canoes in his book (1866:65-66) mentions only that "a small image was generally placed inside near the stern". Brenchley (1873:title page) shows an indistinct dog on an Ulawa bonito canoe, presumably drawn from a canoe seen there in 1865. This is obviously not the Ulawa *lisi* canoe collected by Brenchley and now in the Maidstone Museum.

Waite (1987:52) does not mention a carved dog in her description of the Brenchley Ulawa canoe at Maidstone Museum but she does say that the stern has been broken off completely. My own examination of this canoe while it was on loan to the British Museum confirms the absence of a dog carving at the stern.

Writing about bonito canoes of Santa Ana and Santa Catalina, Davenport (1990:104) describes a carving of a dog as one of the distinguishing decorations of a bonito canoe. Usually depicted holding a bonito in its muzzle, this is said to represent the origin myth of ritual

fishing for bonito, several versions of which relate a supernatural event wherein a dog catches a bonito. Davenport reports that some experts of Santa Ana and Santa Catalina maintained that the dog carving is a recent decorative innovation borrowed from Ulawa.

There is a shell-inlaid carving of a dog on the inner stern of the bonito canoe attributed to Ulawa in the British Museum (Mendana 1901:xxii). Ivens (1927:152) and Haddon (1937:94) mention dog carvings on bonito canoes, while Mead (1973b:23) figures a diagram of a dog carved on the stern of a generalised Santa Ana and Santa Catalina bonito canoe. Pendergrast (Ethnology Department files, Auckland Museum) saw and photographed a dog carving on the stern of an old inlaid bonito canoe at Su'umoli village on Ulawa in 1973.

However, the absence of a dog carving on the Auckland Museum bonito canoe emphasises that a dog carving on the stern was not a constant feature of Ulawa bonito canoes. Similarly, judging from the three other later bonito canoes in Auckland Museum, respectively from Santa Ana, Santa Catalina and southern Malaita, a dog carving at the stern is not a universal feature of bonito canoes from these islands either. In some cases this place was taken by the carving of a bonito or a shark.

Complicating this discussion is the possibility that at some times and/or at some places in this area of the Solomon Islands, there may not have been a separate type of canoe dedicated solely to bonito fishing. It has been suggested that perhaps canoes used for other purposes might also have been used occasionally for bonito fishing. Given the long time-span from Labillardiere's observations in 1793 to the present, there are probably several answers to this question, complicated further by the spread of Christianity. However, the accounts by Ivens, Davenport, Mead and others certainly make it clear that in the time of their fieldwork, bonito canoes constituted a specific type of canoe distinct from all others and reserved for the purpose of bonito fishing.

THE AUCKLAND MUSEUM BONITO CANOE FROM MADOA VILLAGE

This canoe is 480 cm long and 60 cm wide (Figs 3,4). The hull is built of separate thin planks, with the joins between them covered by a thick ridge of black parinarium gum. Two long narrow planks form the flat keel and these are joined to one wider side plank on each side, with their curves produced by skilful adzing. Above these side planks, one narrow gunwale plank runs the full length of each side.

On the inside, there are only two cross ribs, situated in the forward half of the hull. These ribs are attached to the interior of the hull planks without the fishhead-shaped cleats seen in both the British Museum and Maidstone Museum examples. In the bow there is a small simple cross-seat, but nothing comparable in the stern.

The up-curved prow and stern reach up to the same height and both finish in the same small peg which originally held the leaf tassels. At the rear of the prow section there is a vertical step in the gunwale line, and the prow is distinguished by more decorative detail. All the profile heads of the shell-inlaid frontal frigate bird motifs and the two sea spirit figures face forward to the bow. Nautilus shell inlay follows all the outer upper edges of the canoe and continues down under the prow and stern to the waterline. Two forms of nautilus shell inlay elements are used on this canoe, both usually with edge notching (Ivens 1927:392). One form is an isosceles triangle, and the other form is a rectangle with a deep V cut-out at both small ends. Details of the decorative patterns will be described below in the section on the symbolism of the canoe. There are no signs of the charcoal and tree juice decorations seen stained into the wood on some bonito canoes (Ivens 1927:153).

Both early photographs of the Auckland Museum canoe show that when collected it was

Fig. 3. "Canoe made in Ulawa to raise money for roofing the church. (From a photograph by Mrs O'Ferrall.)" Photograph probably taken on Norfolk Island in early December 1897. (After Awdry 1903:103).

Fig. 4. Canoe from Madoa, Ulawa, photographed in Auckland Museum grounds sometime between 1897 and 1925. Photo: Auckland Museum Negative 17638/C 24323.

decorated with red plant fibre tassels at bow and stern, as befitting a complete bonito canoe (Figs 3, 4). These are now missing and were probably lost long ago. Several writers have commented on the importance of these red tassels as part of the necessary decorations for a bonito canoe (Brenchley 1873:249, quoted above; Davenport 1990:105; Haddon 1937:94; Ivens 1927:134; Labillardiere 1800:277, quoted above). The same red tassels were worn by the bonito initiates and were attached to special ceremonial haircombs. Ivens (1927:383-384) has described how these tassels and streamers were prepared from the leaves of the fan palm, *aleale*, and then dyed with scrapings from the *lelemo* tree and the root of the *kikiri*.

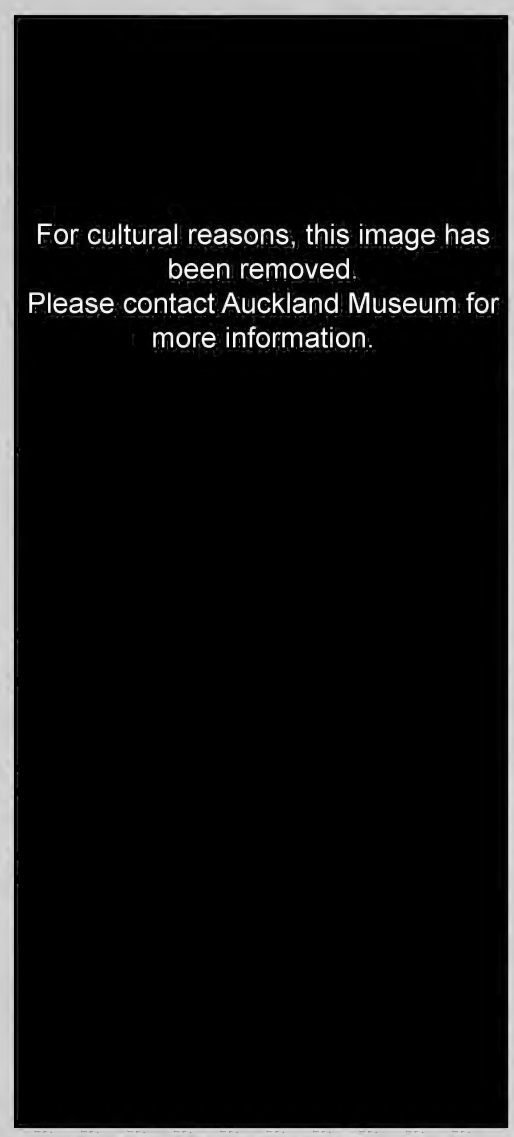

Fig. 5. Paddle (AM 12108) from Madoa, Ulawa. Photo: Auckland Museum.

In his letter accompanying the canoe (see below), Ivens noted that the two paddles that came with it had actually been used. This implies that they were probably not made expressly for this canoe. They conform to the distinction first noted by Codrington (1891:297) between the narrow pointed paddles of the eastern Solomons and the broad short-bladed long-handled paddles of the western Solomons. As with other eastern paddles, these two are narrow and pointed with a crescent-shaped handle. One of the paddles (AM 12108) has a handgrip in the form of a bird on a square pedestal (Fig. 5) decorated with nautilus shell inlay that continues down the shaft on both sides.

THE HISTORY OF THE AUCKLAND MUSEUM CANOE

The earliest photograph of this canoe (Fig. 3) was published by Awdry (1903:103) in his popular book on the Melanesian Mission, with the caption "Canoe made in Ulawa to raise money for roofing the church". This photograph was taken by Mrs O'Ferrall who is listed as a European lay worker of the Melanesian Mission. She was the wife of the Rev. O'Ferrall, famous for his missionary work on Santa Cruz. It was almost certainly taken in early December 1897 at the Melanesian Mission headquarters on Norfolk Island while the canoe was on its way to Auckland on the *Southern Cross*. The photograph shows the canoe complete with a paddle at each end and fortunately also illustrates the red dyed leaf tassels at prow and stern which have since disappeared.

A later photograph of the canoe (Fig. 4), still with its tassels intact, was apparently taken outside at the former Auckland Museum building in Princes Street. This is probably the photograph taken by museum staff at the request of Rev. Ivens in 1925 when he intended to include the canoe in his forthcoming book on Ulawa (Ivens 1927), but for some reason it was not used.

In the Auckland Museum's records, this canoe is registered as AM 12106 and its two shell-inlaid paddles are numbered AM 12107 and AM 12108. These three items were purchased from the Rev. Archdeacon R.B. Comins in 1897, for a total price of £12. The canoe and its paddles had been brought to Auckland on the *Southern Cross*, after its last trip around the islands for 1897. The *Southern Cross* reached Norfolk Island on 6 December 1897, which is also the date of Ivens's letter to the museum's curator, Thomas Cheeseman. The ship then reached Auckland on 19 December 1897, which is when the Ulawa canoe was probably delivered to Auckland Museum.

In a handwritten letter, Rev. W. G. Ivens wrote to the Auckland Museum supplying information about the canoe, as requested by his colleague, Archdeacon R.B. Comins.

> Norfolk Island December 6th 1897
> The Museum Curator, Auckland.
> Mr. Comins has asked me to write some account of the canoe forwarded to you per Southern Cross.
>
> It is a full sized 2 man canoe and a boy can be taken as well. One man thus wd. sit on the front seat, the boy in the middle & the 2nd man aft on a bit of board laid across the bottom of the canoe.
>
> The two paddles are full sized & have actually been in use.
>
> As Mr. Comins has written, the canoe was made by the Church people of Madoa, Ulawa, & the proceeds from its sale are to be devoted to a fund for the supplying of iron for a Church wh. the Rev. Clement Marau & his people are building at Madoa.
>
> Such a canoe as this one offered to you wd. have been used in heathen days & used almost exclusively for bonito fishing & would have been very sacred women would have been prevented from seeing it.
>
> The frigate birds or man of war hawks (kaula is the Ulawa name) are associated with the bonitos & the presence of a flock of them anywhere always indicates the presence of bonitos. Sacrifices were offered to Kaula, a kind of disembodied ghost, associated with the bird, & in all the Ulawa decorations Kaula has a foremost place.
>
> If Kaula's favour could be won, then the bonito fishing wd. be successful & reversely any one successful in bonito fishing was regarded as one befriended by Kaula.
>
> Between the Kaula on each side of the canoe is the representation of a "ghost of the deep" (akalo ni matawa). On the near side one stands on a rainbow & the off-side one has a fish head & an arrow in his right hand & a bow in his left preparing to shoot the poor fisherman.
>
> The front of the canoe is cut in tattoo fashion on both sides, also there is a bird cut holding a fish in its mouth.
>
> Then there are 2 birds' wings, one on each side & 2 fishes fins, one on each side.
>
> The square towards the bottom in the front represents clouds as does the pyramidal piece of shell on both side of the front.
>
> Then there are other birds in the front & on the stern.
>
> The canoe is made of good wood, the raised part of stem and stern is of specially good red wood called "liki". The canoe builder is renowned for the lightness and neat construction of his canoes. The inlaying was done by the people as a whole.
>
> The grassy looking decoration dyed and red is from Malanta [Malaita] & is much sought after by Ulawa people.
>
> I trust that you will see your way to give us the price we ask for the canoe 12 pound- as a piece of work the canoe is perfect—such a good specimen has never been offered for sale before & the people say that they never turned out such a piece of work before. This canoe represents part of the offerings of the natives themselves towards the building of their big church—
> I am Sir yours etc.
> W.G. Ivens
>
> (Auckland Museum files)

The comments by Ivens advertising this canoe as "perfect" and better than any canoe made

previously indicate that it may not be a typical example of an Ulawan bonito canoe. As a first point, it appears never to have been used for fishing. Ivens makes a point of saying that the paddles had been used, which strongly suggests that the canoe itself had not. In a later letter to the museum (Ivens to Cheeseman, 18 September 1925, Auckland Museum files), Ivens reiterates that this canoe was "made at my suggestion originally" to raise funds for the church roof.

If it is not typical, then the question becomes one of how does it differ from other bonito canoes. Being made by church people for sale to a museum might have encouraged the craftsmen to take extra care with the workmanship and to make the decoration more elaborate than usual. Or the opposite effect may have occurred because it was being built for ignorant outsiders. In the same 1925 letter, Ivens also mentions that this canoe is a one-man canoe, in contrast to his earlier claim that it was a two-man canoe, and is inferior because it has only nautilus shell in the decorations and no *la'o* cone shells. The most obvious difference is its small size, suggesting that it is best considered as a slightly reduced model of a usual bonito canoe with some limitation in the range of its shell inlay decorations. Nevertheless, despite its small size and restriction to nautilus shell inlay, the high quality of workmanship and great amount of inlay strongly support the view that this canoe was honestly intended to show the best of Ulawa canoe construction and decoration. By this time, Ulawa was already well known as a source of small model canoes made for sale to passengers on the mission ship. From this perspective, the Auckland Museum canoe might be regarded as a superior, slightly reduced-size model made for a specific purpose, exemplifying a different moment in the commodification of Ulawan canoe culture.

BONITO FISHING IN ULAWA CULTURE

Writing for his audience of mission supporters in the *Southern Cross Log* for 1897, Rev. Ivens has given a very lively contemporary account of bonito fishing at Ulawa from canoes such as the Auckland Museum example:

> In old days the great fishing feat was to catch bonitos; these go in a shoal, and their presence is usually indicated by a circle of birds flying overhead, and now and then darting down to secure for themselves some of the small fish which the bonitos are chasing. As soon as the fish were espied—either by means of the accompanying birds or through bright lines left on the water as they leapt here and there in chase after their smaller brethren—then down would go the canoes, two men to each, and then began the race to get up first. The canoes almost flew along, so eager were their owners to excell in this the greatest of sports. As the canoes neared the fish, the bow-man ceased paddling and began to cast with his rod and line in amongst the fish, while his companion kept the canoe going, and also looked after a line that trailed astern. The hooks used are made of pearl or clam shell, or of tortoise shell, and serve for both hooks and bait in one. Those cast with the rod are of ordinary hook-shape, and have an imitation fish cut on them; those dragged astern are made of a straight piece of clam or pearl shell with the downward side carved to imitate the look of a small fish, and on the upward side as it floats is fastened a hooked piece of tortoise shell. Both these big bonito hooks, and also the small hooks, used when fishing from the rocks, exhibit the most perfect workmanship. An infinitude of time must have been expended over their making, and yet a stick or so of tobacco will purchase the best of them. The bonito was a sacred fish, and when caught they were cooked and eaten in the places sacred to the spirits, where the women might not enter. (*SCL* II(22):27-28, Feb 1897)

In his later ethnography of Ulawa, Ivens (1927:130-159) gave a full account of the role of bonito fishing in the *malaohu* initiation of young boys in Ulawa, as does Mead (1973a) for Santa Ana, and Davenport (1981; 1990) for Santa Catalina. In Ulawa, the young initiates underwent a period of seclusion in the canoe house, *taoha*, which also served as a 'custom house' where the men gathered and spent much of their time. Here they carried out the rituals connected with the bonito canoes and their ancestors. Canoe houses were built around canoe landing places called *maalitawa* in Ulawan, situated at small inlets with an opening in the shore reef and access up the coastal cliffs of the island. Hendren (1976:152) has described the archaeological remains of earlier canoe houses on Ulawa in the early 1970s, among which were still-functioning canoe houses containing shell-inlaid bonito canoes. Similarly, Pendergrast in 1973 photographed bonito canoes at several villages around Ulawa (Auckland Museum files).

When not in the canoe houses on the beaches, the older men, young unmarried men and *malaohu* boys of Ulawa congregated and slept in the *toohi* which served as a clubhouse in the village (Ivens 1927:46-47). Several of these *toohi* 'custom houses' on Ulawa were photographed by Beattie (see note 2) during his 1906 visit on the *Southern Cross*. Waite (1997) has described several custom houses, both of the canoe house and council house varieties, from localities in the south-east Solomons.

SYMBOLISM OF THE BONITO CANOE

Several recent studies (e.g. Phillips and Steiner 1999) of non-Western artefacts intended largely for trade and sale have demonstrated that many of these forms of art still exhibit all the communicative and signifying qualities of 'legitimate' or 'authentic' works of art. This is especially clear when the same types of objects are being used simultaneously within the culture, as was the case with the Auckland Ulawa canoe. Nevertheless, we must be aware that the actual messages and meanings conveyed by these objects will be very different for the indigenous users and the external collectors or consumers.

Many writers on various south-east Solomon Islands cultures, including Ulawa have commented on the manner in which bonito canoes and their associated rituals constitute a central cultural focus for the coastal peoples in this area. Unlike the other important decorated canoes used in trading and travel which have a recognized economic aspect, the bonito canoes are sacred ritual objects operating in the spiritual domain. Their construction represents an attempt to realise an ideal form, both in aesthetic and spiritual terms. Writing of the canoes of Santa Ana and Santa Catalina Islands in the 1960s, Davenport (1990:99-100) has explained how most bonito canoes were self-perpetuating votive offerings made by important men to their tutelary deities. A few other bonito canoes were constructed as ancestor memorials, sponsored by a lineage. Davenport (1968:22) especially, saw the sacred bonito canoes and the canoe houses where they were kept as the main locus where "the secular domain of man intersects with the sacred domain of the deities".

Given this central cultural role of bonito canoes as material representations of the relations between humans and the supernatural, it is to be expected that the symbolism of the bonito canoes will convey very powerful messages (Figs 6, 7). Most prominent are the motifs rendered by inlays of nautilus shell and conus shell, set in rows and outlining figures such as birds and fish. The small triangular and rectangular pieces of nautilus shell are readily cut from the thin shells of nautilus which drift ashore and consequently have minimal intrinsic value. The larger round and half-round discs of conus shell, *la'o*, are much thicker and required intensive labour to grind them down to the required shape. Consequently, the conus discs have considerable intrinsic value and are always rescued from old worn-out objects and reused, virtually becoming heirlooms.

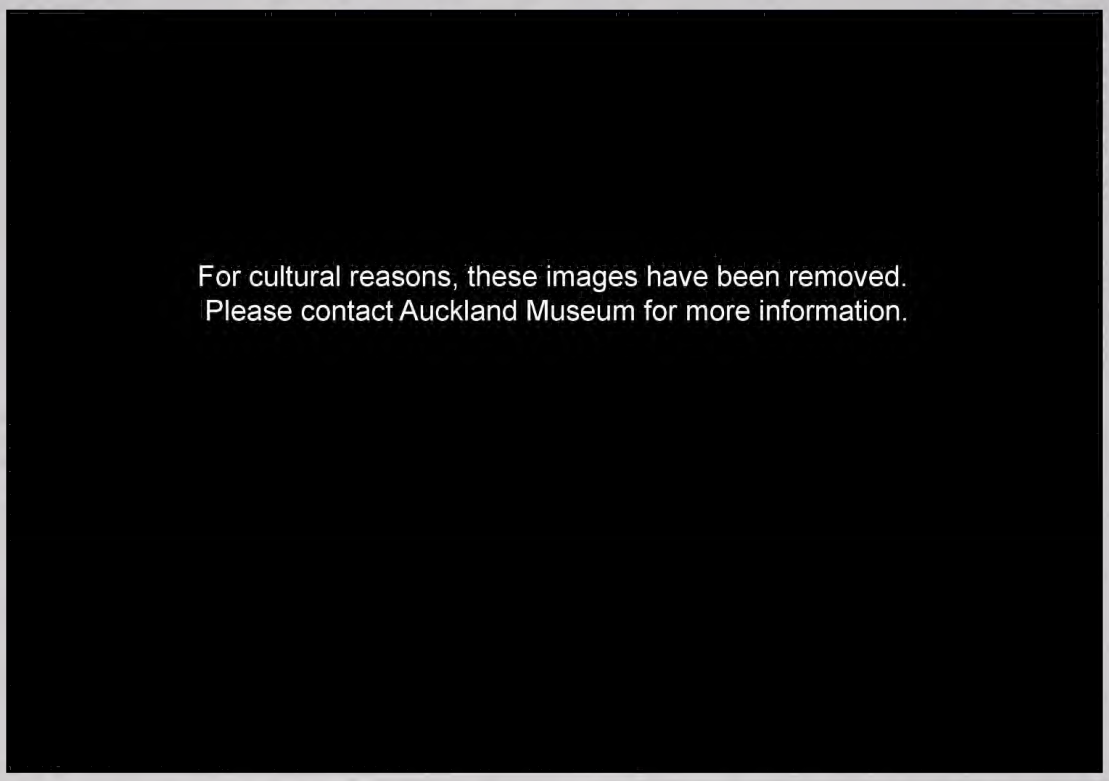
For cultural reasons, these images have been removed.
Please contact Auckland Museum for more information.

Fig. 8. Nautilus shell inlay representing frontal frigate bird. Right side of Ulawa bonito canoe. Photo: Auckland Museum.

In his letter about the Auckland Museum canoe, Ivens identifies the frontal stylised birds depicted by the shell inlay as frigate birds or man of war hawks, known as *kaula* on Ulawa (Fig. 8). He explains that Kaula, as a disembodied ghost associated with these birds, had the power to ensure successful bonito fishing, provided his favour had been gained by appropriate sacrifices. Codrington (1891:126, 145) also notes that Kaula as the frigate bird is venerated at Ulawa, and as Daula at Florida (1891:145). It is this sacred character of the frigate bird in association with bonito fishing that accounts for the bird's widespread occurrence in shell inlay ornament throughout the Solomons. Very similar shell-inlaid profile frigate bird motifs are shown along the side of a *la'o* inter-island canoe figured by Ivens (1927:frontispiece), but they are not recorded elsewhere as occurring on the sides of Ulawa bonito canoes.

On both sides of the Auckland canoe, at prow and stern, a profile inlaid bird figure faces into the middle of the canoe (Figs 9, 10). These are referred to by Ivens in his letter as "other birds", but they would seem to be representations of frigate birds also. In addition to these frontal and profile birds represented solely by shell inlay, the canoe also features one frigate bird on each side at the upper rear of the raised prow section just in front of the vertical step in the gunwale (Fig. 11). Facing towards the bow, the body of these birds is represented by shell inlay on the solid timber of the gunwale edge, but the bird's head and a fish that it is holding in its beak are carved out of the gunwale in three-dimensional open-work. On the left side, the bird's head has since been broken off. Although Ivens's letter does not make the observation, it can be suggested that the stirrup-shaped line of shell inlay projecting down from the shoulders of the bird might represent the bird's wings shown with the characteristic sharp-angled joint of a frigate bird's wing.

Fig. 9. Nautilus shell inlay representing profile frigate bird. Left side stern of Ulawa bonito canoe. Photo: Auckland Museum.

Fig. 10. Nautilus shell inlay representing profile frigate bird. Left side bow of Ulawa bonito canoe. Photo: Auckland Museum.

Fig. 11. Detail of right side bow of Ulawa bonito canoe, showing inlay and open-work carving depiction of bird with fish in its mouth and tattoo pattern below the bird's body. Photo: Auckland Museum.

Immediately below the body of the birds described above, is an area of incised geometric decoration perhaps with black pigment in the lines (Fig. 11). In his letter, Ivens describes this pattern as "cut in tattoo fashion", presumably referring to body tattoo patterns seen on Ulawa. In fact, this particular pattern does not closely match any of the Ulawa tattoo patterns reproduced by Ivens in his book (1927:83). However, the pattern on the canoe is virtually identical with the side facial pattern of *segesege* or unpigmented tattoo from Santa Catalina reproduced by Mead (1973a:31). Mead comments that each tattoo artist and *segesege* artist have their own favourite compositions, and similarities among Sa'a, Santa Catalina, Ulawa and other south-east Solomons areas are confined to the motifs used on the side of the face. In Sa'a and Ulawa, pigment is added to these facial markings.

Ivens mentions two birds' wings and two fishes' fins, inlaid one on each side of the canoe (Fig. 12). The bird wing with a characteristic frigate bird sharp-angle joint, rises from the lower edge of the bow. Ivens does not mention it but the fish fin depends downwards from a darkened wood area with the shape of a fish's head which is followed by an inlaid straight body line ending in an upright tail fluke. Therefore, this apparently isolated fin motif can be reasonably interpreted as part of a larger fish-form composition.

As described by Ivens, the inlaid square pattern (Fig. 12) at the end of the line of inlay under the bow represents clouds, as does the triangular pyramidal piece of shell set above the line of inlay in the central part of the prow. Another relationship to tattoo patterns is suggested by the similarity of this Ulawa triangular shell inlay 'cloud' motif to an Ulawa tattoo "cloud" motif figured by Ivens (1927:85).

The human-like figures inlaid one on each side of the canoe are identified by Ivens in his letter as "ghosts of the deep", or in Ulawan, *"akalo ni matawa"*. The figure on the left side of the canoe (Fig. 13) faces towards the prow and stands on a structure with up-curved ends. In his

Fig. 12. Detail of right side bow of Ulawa bonito canoe showing inlay depiction of fish with dependant fin, rectangular cloud motif and angled bird-wing. Photo: Auckland Museum.

Fig. 13. Figure of sea spirit with fish head riding on a canoe or rainbow. Left side of Ulawa bonito canoe. Photo: Auckland Museum.

Fig. 14. Figure of sea spirit with shark head holding a bow and arrow. Right side of Ulawa bonito canoe. Photo: Auckland Museum.

letter, Ivens identifies this as a rainbow, while in his book (Ivens 1927:33) a wood carving of a sea spirit riding on a similar shape is said to be seated on an *iola ho'i*, that is, a canoe with turned-up ends. Comparison of the head-form on this Ulawa canoe sea spirit figure with others drawn by Ulawan artists (see below) confirms that this inlaid figure also has a fish for a head. The sea spirit figure on the right side of the canoe (Fig. 14) also faces forward but stands on a flat base. His head is very clearly depicted in the form of a fish, probably a shark judging by the upright dorsal fin. In his hands he holds a bow and arrow, ready to shoot an offending fisherman.

Unfortunately Ivens did not say specifically which particular sea ghosts are represented on this canoe. Several native drawings or carved representations of these sea spirits from Ulawa, Sa'a and other places have been published by Codrington (1891:197, 259), Fox (1924:125, 126, 127, 128), Ivens (1927:33, 201, 202, 204, 206) and Waite 1979:256-260). Some of these published figures show the attributes of bow and arrow, rainbow or canoe, shared by the Ulawa canoe inlays. Out of the 15 figured, 14 have their head depicted as a fish, of which only one or two look as if a shark was intended. This probably relates to the figure on the right side of the Auckland canoe, which seems to have a shark for its head.

According to Fox (1924:124 ff.), Ivens (1929:199 ff.) and Waite (1979:256-258), these spirit beings are called *akalo ni matawa* at Sa'a and Ulawa, *adaro ni matawa* at San Cristobal, and are known by other cognate terms in other parts of the south-east Solomons. *Akalo ni matawa* are not ghosts of dead men, rather they are spirits that have always lived in the open sea or *matawa*. They are usually represented as partly anthropomorphic and partly fish-like, and are thought to live far out at sea or near small islands along the coast. The people of Ulawa think of San Cristobal as the original home of these sea spirits. They are mostly malevolent

spirits who shoot fishermen with bows and arrows of garfish if they have been offended or are not satisfied with sacrifices. At Ulawa, the offerings usually made to the sea spirits are flying fox teeth and dried almonds. Rainbows and waterspouts are their special signs, to be avoided by people out in canoes because these are the paths by which the sea spirits travel. Many of the canoe landings around Ulawa are under the care of particular *akalo ni matawa*.

On Ulawa, the worship of sea spirits was called *haraina*. Fox says that the chief of them is called Ngoriaru and he is known by that name in south Malaita, Ulawa and all of San Cristobal. Two subordinate chiefs of sea spirits in Ulawa are known as Huaholai matawa and Hanai matawa. Ivens recognises that Ngorieru (note spelling difference) is the chief sea spirit at Sa'a, but maintains that the chief sea spirit at Ulawa is Pua Tangalu. Other sea spirits at Ulawa named by Ivens are Wasi i matawa, Hui holai matawa, Hana i matawa, and Sii aleha. Given the extremely variable representations of different sea spirits, it is probably not worthwhile trying to specifically identify the two on the Auckland Museum canoe.

Apart from the sea spirits and profile frigate birds inlaid on the sides and the absence of a dog carving in the stern, most of the decorative design elements on this Ulawa bonito canoe can be matched in form and placement on a generalised south-east Solomons bonito canoe as diagrammed by Mead (1973b:23).

ULAWA IN THE SOUTH-EAST SOLOMONS CULTURE AREA

Ulawa was once a famous centre for the manufacture and sale of canoes to southern Malaita, Uki and San Cristobal (Codrington 1891:294; Ivens 1927:8). Santa Ana informants told Mead (1973b:25) that their ocean-going *risu-e-rima* canoes were formerly manufactured only in Ulawa and Santa Ana for sale to the mainland of San Cristobal. Ulawan canoes had a reputation throughout the south-east Solomons for being lighter and more artistically made than other island canoes. Beyond the supplying of canoes, Ulawa was also a source of technical and ritual skills necessary for inter-island canoe travel. As Mead (1973b:59) has said, "Ulawa men were respected for their skills, feared because of their powerful sea deities and military powers, and hated for their success." Within the wider south-east Solomons area, by virtue of these skills and its location, Ulawa occupied a very special position in the cultural and art area bounded by San Cristobal, south Malaita and Ulawa (Mead 1977:156-161). In trade and cultural relationships, Ulawa dominated the western part of San Cristobal and acted as a "gatekeeper" in this area's relations with more distant areas of the Solomons to the north. Ulawa people placed a higher value on themselves and their products (Figs 15, 16), as evidenced by the copying of Ulawa arts and styles by people of these dominated areas and the higher bride price demanded by Ulawa in dealings with Santa Ana.

Without being systematically aware of this wider picture, European missionaries were repelled and challenged by the pride and apparent arrogance of Ulawa culture. As Ivens wrote in 1898:

> Those who knew Ulawa in old days could tell a tale, for Ulawa once had a terrible reputation. Self-will, blind, ignorant fanaticism, all had their exponents here. The Gospel and its teachers were flouted out, and there was only wanting the power and the opportunity to be rid of them all. For greed and rapacity, I believe, the people had few equals. For nothing, one got nothing in return; and for gifts the return was nothing too; and often the present was hurled back at its giver, because something else was wanted instead. An axe was once actually thrown down at Bishop Selwyn's feet, because a few books were wanted instead; and the very children had to be 'bought' to come to school, and the rule was 'no present, no schooling'. And as far as their heathenism was

Fig. 15. Non-Christian men of Ahia village, Ulawa, wearing their traditional valuables and ornaments, 1906. Photo: Beattie, Auckland Museum.

Fig. 16. Men's custom house with large shell-inlaid food-serving bowl in form of bird-holding-fish, called *nima-ni-oni*. Ahia village, Ulawa, 1906. Photo: Beattie, Auckland Museum.

> concerned, the Ulawa people were most diligent in their observances of their worship of 'ghosts'. Sacrifices were offered on every possible occasion—for rain, for fine weather, as first-fruits, for bonito catching, at the launching of a new canoe, for victory, for deliverance, etc., etc. (*SCL* IV(43):11, Nov 1898)

In this missionary view of Ulawa culture, Ivens illustrates a classic case of European misunderstanding of Melanesian views on reciprocity. The European missionaries believed they were bringing free gifts of goods, new skills, and spiritual enlightenment. They expected to be thanked, or at least for the Ulawans to show some gratitude. For their part, the Ulawan leaders who were accustomed to dealing with outsiders from a position of dominance, suddenly found themselves expected to assume a position of inferiority, as inferior receivers of gifts instead of superior gift givers. For a Melanesian society based on economic status where 'gifts' served to place receivers into a state of obligation, the arrival and persistence of these outsiders must have been seen as a fierce challenge.

CLEMENT MARAU, APOSTLE OF ULAWA

Fox (1958:162-163) and Hilliard (1978:171-173) have summarised the story of the development of Christianity on Ulawa, beginning with the departure of Walter Waaro to Norfolk Island with Bishop Patteson in 1870. When Waaro was due to return to Ulawa as a Christian teacher in 1880 he felt inadequate for the task and asked his older friend at Norfolk, Clement Marau (Fig.17) of Merlav (Merelava) in the Banks Islands, to accompany him for the first three months. Marau had gone to Norfolk Island in 1869 and had been confirmed in 1875. Marau went with Waaro and eventually stayed on as the main local missionary at Ulawa until his death in 1920. This period was interrupted by Marau's suspension from office in 1907 for adulteries with local women.

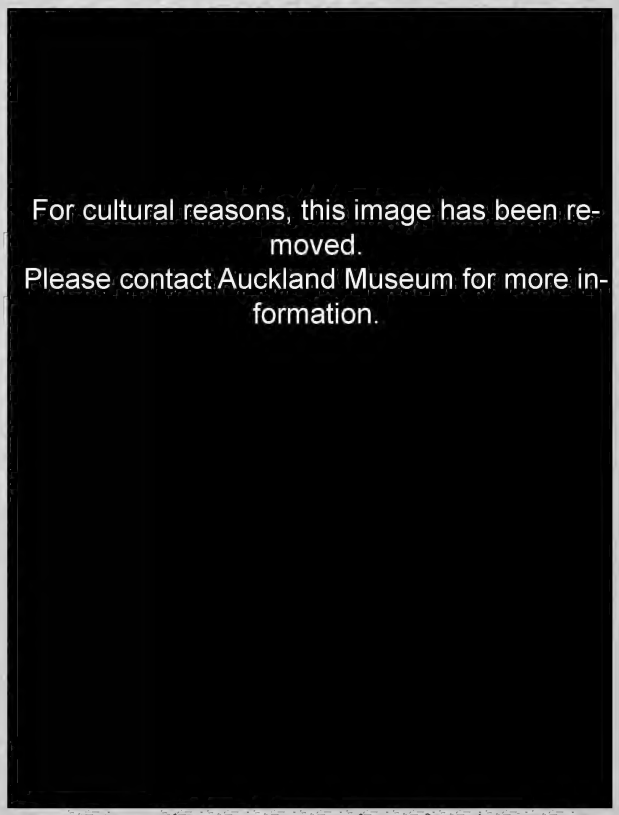

Fig. 17. Rev. Clement Marau at door of Madoa Church, Ulawa, 1906. Note locally-made, shell-inlaid church furniture. Photo: Beattie, Auckland Museum.

Clement Marau's own life story has been told many times, in addition to his autobiography (Marau 1894) which takes him up to 1894. Fox (1958:162-163) and Hilliard (1978:171-173) give useful summaries, noting that he was ordained deacon in 1890 and priest in 1903. Marau does not mention it himself, but in the context of this study it is also important to note how he learnt to do shell inlay in Ulawa style and began selling inlaid bowls to raise money for his bride price, as explained by Fox (1958:163):

> He wished to marry an Ulawa girl, but a prohibitive price of £50 was asked, so Marau learnt to carve and inlay, made bowls and sold them till he got the money. He married Susie in 1883.

Considering the effort that it took to raise £40 in the 1890s for his Ulawa church roof, £50 seems an excessive amount to have raised single-handed in about three years but it was probably quoted as a convenient and impressive round figure. In any case, Clement probably did not have to raise the full amount himself but was helped by the efforts of his own kin from Merlav.

Bishop Montgomery writing before Marau's suspension, described Marau at the height of his success:

> As years have passed, Clement has strengthened his position steadily... There are, I believe, no heathen in his island now. His church is a noble coral structure, and he lives to be the most respected and the ablest native priest in the Mission. (Montgomery 1908:220)

Some years after his suspension, Clement was eventually readmitted to communion but his position on Ulawa remained a source of disturbance until his death in 1920. His elder son Martin was ordained deacon in 1919 and became the next leader of the Ulawa church.

MADOA VILLAGE BY THE END OF THE NINETEENTH CENTURY

The name of Madoa village has been spelt in many different ways, among them Mwadoa, Matoa, Mwatjo'a, Mwado'a, and Mwadjo'a. Hendren (1976:164) includes a useful map of Ulawa, spelling the name of this village as "Mwdo'a".

The progress of Christianity in Ulawa and Madoa has been well documented by mission writers, although their critics of the time claimed that mission-reported numbers of converts were hopelessly optimistic. Madoa was one of the early success stories on Ulawa and it soon came to be regarded as an approved model mission village, held up as an example to visitors and Ulawans alike (Figs 18, 19).

According to Ivens (1927:46), pagan Madoa had four chiefs, each with a landing place of his own, a canoe house and a club house. The ceremony for *malaohu* boys was last held at Madoa under the chief Lakai Malau in about 1860 (Ivens 1927:132). This cessation of the *malaohu* ceremonies marks a major phase in the decline of the old religion. By 1896 Ivens could report that out of the nine villages on Ulawa, four had mission schools, and of these Madoa had nearly all its people baptised (*SCL* II(22), Feb 1897). Many mission visitors of the mid-1890s commented on the successful transformation of Madoa:

> It was terribly uphill work at first—now, every village of Ulawa wants to have a school. We visited four places, and everything seemed most encouraging. Of course, the most interesting spot of all is where Clement Marau lives at Matoa. It is very wonderful to see what has been done here. The landing place is bad. There are great masses of coral rocks, and the boat has to move amongst them very slowly, and when the landing place is reached one has to climb up a sort of rude ladder to the higher ground above. A good number of people had collected there and as we walked up a sort of avenue to the village we met Clement. It is one of the largest and perhaps the best-kept village in the Mission. The houses are large and well-built, and not all over the place as is the general way, but arranged on each side of a long and fairly broad open space, which has almost the

Fig. 18. General view of Madoa village, Ulawa, 1906, showing arrangement of clean, neat streets and Christian converts wearing European clothing. Photo: Beattie, Auckland Museum.

Fig. 19. Mission house in Madoa village, Ulawa, 1906, with missionary visitors from the *Southern Cross* resting on the porch. Photo: Beattie, Auckland Museum.

> appearance of a street. There is a general clean-up once a week as at Norfolk Island, and everything was beautifully tidy the day we were there. (*SCL* II(16):3, Aug 1896)

In his report for 1896, the Bishop of Melanesia detailed how these changes were affecting the people of Madoa:

> May 2—The third [village visited on Ulawa] is the Rev. C. Marau's village. It is a model of cleanliness, and built in good taste. There are eighty children and young people, and fifty adults going to school here. Christianity is certainly in possession in Matoa, but the island generally is only in a transition stage, and walking the street of this village, amongst its clean, nicely-clothed people, are naked visitors from other places, some utterly regardless of their nakedness, others ashamed of it, and trying to hide themselves behind trees and in houses when the people come together. If they could be baptised and become Christians at once they would do so, but they dread the interval between renouncing their present gods, and being received into the kingdom of the true God. During this time, when they are nobodies, their forsaken gods might catch and punish them for their desertion. Hence they remain where they are, and are naked. The first step a man takes towards becoming a Christian is to put on a loin cloth. Then he attends classes for a year or more, after which he is baptised. (*SCL* II(22):4-5, Feb 1897)

In contrast to the Bishop's European perspective of what clothing meant for the converts, Marau (1894) tells how new adherents were so embarrassed when they first put on the loincloth to signal their new status.

Under this new Christian regime, the rhythm of life in Madoa had taken on an emphasis based around the Sabbath:

> A bell rings at nine o'clock each night, sending everyone to their homes; no one being permitted to loiter about after that bell has rung. On Sundays the people meet for a social meal at mid-day. The fish is caught, and all the food prepared, on the Saturday. Young and old, Chiefs, Teachers and people here all meet together. In large bowls the food is brought in, and divided out to all alike. If there have been any quarrels among the people, coming to the social meal is a sign that such are ended. Conversely, if any stop away, it is a sign that the offence is not forgiven, and that something yet remains to be done. (Marau, quoted in Hilliard 1978:171-172).

THE BUILDING OF THE MADOA CHURCH

In his biographical account of the first conversions on Ulawa, Marau (1894:78) described what became the place for his new church, if not the exact spot:

> There still remained one sacred place in the middle of the village [Madoa] which some of the people had reserved by their own choice, asking me if I pleased not to destroy it, and they would build a house sacred to God in the place of it. I agreed that it should so remain for a time, but said that it would be well to clear the place underneath, cutting away the creepers and chopping down the big trees; the stones with which it was fenced should be carefully piled in a heap, and at some future time we would see what could be done.

In his proselytising zeal, Marau had already destroyed many sacred places associated with spirit worship, destroying their charms and emblems, chopping down sacred groves and desecrating sanctuaries.

The Melanesian Mission Report for June 1896 (*SCL* 1896:xii) notes that, "Clement has started a fine church, the walls of stone and concrete, and the roof to be of native timber." In this same report, Rev. R.B. Comins (*SCL* 1896:xli) wrote:

> From here we steamed round to Matoa, where the Rev. Clement Marau is stationed, where we found all. He and his people had long desired to have a special building for divine worship distinct from that used for school purposes. With this object they had cleared and leveled a suitable site in the centre of the village, and were now waiting for some practical hints before laying the foundations of a substantial stone church. The people were all very enthusiastic about it.

From this time on through 1896 to 1898, the building of the new church at Madoa (Figs 20, 21) is a theme running through all the issues of the *Southern Cross Log*, both from the points of view of visiting Europeans and of local Ulawans. In 1896 a visiting missionary wrote:

Fig. 20. Madoa Church, Ulawa, 1906, showing the coral block walls and corrugated iron roof built under Rev. Clement Marau's direction. Photo: Beattie, Auckland Museum.

Fig. 21. Interior view of Madoa Church, Ulawa, 1906, showing coral block walls, corrugated iron roof, steps of sawn white coral paving in the apse, and church furniture. Photo: Beattie, Auckland Museum.

> About the middle of the street, Clement is building the new church, which is the wonder of all who see it. The material used is white coral, which is carried with immense labour from a considerable distance. The walls are perfectly straight, very substantial at the bottom, and gradually growing less thick. The apse is circular as at Norfolk Island, and there are three arched entrances. He has also built a stone vestry. The roof has not yet been begun. Clement said people came from all places to see the church. Some thought it foolish to work so hard, some only wondered, and some were offended because they had not been asked to help. (*SCL* II(16):3 Aug 1896)

The Bishop reported on his 1896 visit to Madoa with a description of work on the church:

> May 2—The church which Clement and his people are building is of coral, cut out of the reef and sawn square. When finished it will be the finest piece of native or European work in the Solomons. He says that the heathen have not hindered the building of it, but have marveled, admired, and occasionally grumbled because they had not been called in to help. The Christians have made it their work alone. (*SCL* II(22):4-5, Feb 1897)

After the 1896 voyage of *Southern Cross*, Rev. Ivens wrote that at Ulawa:

> Clement is very busy now cutting trees and sawing timbers for his church and herein his people's love for him and for the work is clearly shewn; one man readily gave the site for the church, and allowed his coconuts and breadfruit to be chopped down, nor did he ask for any remuneration; and the men of the village will all readily in turn give gratis a day or two days of their time in helping in any part of the church building that may be going on. The church walls are 72ft. long by 36 ft.wide, and are of sawn coral, cut and placed by Clement; they are about 3ft. wide at the bottom and slope up from both sides to about 9in. The whole is 8ft. high. The east end has an apse. It is the timber for the roof that Clement is now cutting. He wants to put an iron roof on, but I am afraid the cost will be too much, £40 at the least, and where is this to come from? Would that some kind friend with a long purse would come our way. (*SCL* II(22):30, Feb 1897)

In March 1897 the Editor of the *Southern Cross Log* made a plea:

> The captain of HMS *Pylades* in speaking of his late visit to Ulawa, writes that he is 'charmed with Clement Marau' and he adds 'I think something might be done to help to an iron roof for his church. If you think so, please put me down for one pound'. The coral walls of Clement's church are now finished, and the question has now to be settled whether it will be roofed with sago thatch which would rot out every six or seven years, staining the walls, or with iron which would cost perhaps £40, but last a very long time. Clement has set his whole heart upon an iron roof, and will probably set aside his salary (£20 a year) to purchase one. We should be very glad to see his wish fulfilled, and will receive subscriptions towards defraying the cost. If the iron could be carried down to Ulawa in the *'Southern Cross'* in April, there is no doubt that Clement would be immensely pleased and encouraged. (*SCL* II(23):2, Mar 1897)

As a result of this plea, contributions ranging from three shillings and sixpence to £4 started to come in from individual Mission supporters (*SCL* III(26), June 1897).

From the first voyage of 1897, Rev. Ivens reported from Ulawa that:

> The Rev. C. Marau's church at Matoa, Ulawa, is approaching completion; he only now wants the roofing. A trader in Guadalcanar happened to visit him a short time ago, and shortly after his visit sent Clement a promise of half the iron required, and the remainder at cost price. This is a great encouragement, and we take this opportunity of thanking Mr Ivensen for his generous gift. It is not always that missions and trade go so happily together in these out-of-the-way parts of the world. (*SCL* III(27):3, July 1897)

But then in February 1898 (*SCL* III(34):10-11, Feb 1898) Clement was reported to be greatly distressed at the death of his four year old son Mark. The church building had come to a standstill but just previous to this the roof of the church had been prepared for the thatching, with 200 bamboo rafters each 23 ft. (7m) long laid the whole length of the church. By August 1897 it was reported that Clement's church had been temporarily roofed with thatch, pending arrival of iron.

An 1898 letter supposedly written by a young Melanesian girl reads:

> We are all very busy building the new church now. We all help to carry the stones and to labour. But Clement has fenced round that piece of ground where the church is being built, and we keep it holy. If we are hungry as we work, and want to eat, we go outside that fence, and we do not carry things inside that fence, only what we want for the church. So when the church is finished it will be very holy. All the people love Clement, and obey him, and fear him, but he is never proud. (*SCL* IV(44):11, 1898)

Archdeacon Palmer writing from the islands in June 1898 for an English audience was very impressed:

> Clement Marau was very well, and gave a good report of the place [Ulawa]—school and work on both sides of the island going on satisfactorily. I was greatly pleased with his Church. One can hardly credit that it was built by Melanesians. The walls are 2 feet thick at the bottom, and slope to 9 inches at the wall plate. It is well and evenly built with solid stone and good lime: as substantial a building as one would wish to see. The Chancel is an Apse, and raised much as the Norfolk Island Chapel is, and floored with oblong slabs of white coral, sawn into shape, and well and evenly laid. I wondered, seeing Clem had no level, how he managed to get it so straight and level. He told me he got a straight and long bamboo, split it, cut out the joints, and used water to give him the level. The stone has all been dressed with axes. I am afraid to say how many he told me had been used up in the process. It is a pity he had not been provided with some mason's hammers. The roof is well and strongly made, and at present is thatched, but the iron is all here for roofing it. Altogether it is a most creditable structure; far and away the best church in Melanesia. (*SCL* English Supplement, V(50), Sept 1899)

The *Southern Cross Log* of November 1898 contains a full account of the building of Madoa church to date, obviously written by Rev. Ivens who regarded himself as Clement Marau's mentor during the building:

> It is now over two years since Rev. Clement Marau began to build his church at Matoa, Ulawa. In civilised lands one hardly expects a clergyman to build his own church, but in Melanesia the better workman a clergyman is, the better chance will there be of his having a good church to worship in. And Clement was determined to have a church the like of which has not been seen yet in Melanesia, and his people nobly supported him in the carrying out of his plans.
>
> The people gave themselves willingly to the work; Clement merely had to state what he wanted, and there were always plenty of volunteers to do what he needed. Philip Huraatea gave the piece of ground for the church to be built on, and cut down several coconut palms and bread-fruit trees in order to provide the necessary space. The church stands right in the middle of the long village, and alongside it a school-house is to built, and possibly a house for the white missionary.
>
> The stone for the walls was all sawn with an old cross-cut saw, rusted and broken-handled. Wherever good boulders were found, blocks were sawn out of them, and then all the people, women included, carried them on their backs to the village. And no light load some of them must have been, for I saw several stones over the doorway at least 3 feet long and 15 inches wide. Slowly the walls rose from a three feet base to a width

of 6 inches at the top, and standing nearly 8 feet high. The stones are all well set in their places in mortar, some of them (sandstone) having a smooth face, and others of rougher coral stone, a jagged one following the line of the coral.

The east end Clement has built apsidal shape, and the apse is to be floored with cut limestone, and is to have four steps. He hopes to have this all ready this summer. The Holy Table is to be made at Norfolk Island, and Clement has great plans for inlaying it with nautilus shell, and when finished it ought to be worth seeing. The seats will be made locally, and inlaid in due time. The pillars for supporting the roof are fourteen in number, seven a side; both they, and the cross beams which they support, are of very heavy wood, chosen specially for its white ant resisting properties, and their dimensions are well in keeping with the size of the building. I spent a month with Clement this year, and we set up the pillars, and mortised the cross beams, and got everything ready to put on the temporary sago-palm leaf thatch. All the timbers fitted well into their places, and the result is a very strong structure; and with the temporary roof on the building looks uncommonly well both inside and outside.

As I wrote before, the church is 70 feet long and 34 wide. Towards the expense of iron roofing we can now, I think, reckon on over £30 (thanks to the kind helpers), and Mr. Soenson [sic] has made a very generous offer of help besides; but there will be many other expenses.

Let me close by telling some interesting things concerning the building of the church. The heathen from the other villages would avert their heads when they passed the church, lest the power of the Spirit, whose it was, should strike them; and if any shavings or bits of wood from the timbers lay in the path, these they would carefully brush aside lest they should tread on them and do despite to the Spirit. Nor could any one of them be persuaded to go inside the walls or even to mount on to the stones of the foundations. And when those who had been working at the church were given bowls of 'pinga' (a yam soup generally provided when there has been any kind of club or associated work on), should any heathen have chanced to be standing near, no persuasions availed to make him eat this 'pinga' with the school people, for he feared lest by eating he would be putting himself into the power of the Christian's Spirit. And yet I heard that even the heathen added their quota to this work of God, for they helped, some of them, to sew the thatch, and, often, one standing by, would help me turn over the heavy timbers in the shed, and they even tried their hands at the wonderful augur. The sewing of the thatch took a whole day and the best part of two nights, and eight hundred bundles of thatch were used (each as much as one would care to carry).

But how I was struck with the reverence of the people; no one of them ever dreamed of smoking inside what were really the bare walls, nor would they sit and chatter inside, but when a man wanted to smoke or to have a chat, he went and sat somewhere outside. All bags and such like things were left outside.
One great cause for wonder is the willingness of the people; and their zeal comes from nothing but the power of the Gospel of Christ. As heathens they had no such zeal, and they certainly have not got it through their being merely civilized. They, themselves, wonder that they should have worked so long and so persistently and with such good effect. (*SCL* IV(43):10-11, Nov 1898)

In a letter dated 10 May 1899 (*SCL* V(51):7, Sept 1899), Clement Marau told Rev. Ivens triumphantly:

> While you have been away, you may see that I have not been idle, for I have finished translating the Acts, and we have sawn all the rest of the stone for paving the east end of the church, and all the steps are laid. My brother, it is good. Just as you and I planned how it should be, so have I finished it, right up to the last step on which the Holy Table stands.

At last, in his "Report on the Island Voyage of 1900", Rev. Ivens could write:

> Owing to the kind help of Mr. Allen Christian, of Norfolk Island, we were able to roof the Madoa (Ulawa) Church with iron, while the ship went west for three weeks on the last voyage. From outside the church looks well, and I hope that everything will be finished inside in time for consecration next August. (*SCL* V(49):20, June 1901)

Finally, the Madoa church was consecrated on 3 October 1901 and given the name St. Barnabas after the parent church on Norfolk Island.

THE LESSON OF THE MADOA CHURCH

As noted above, the last pagan canoe rituals and initiations took place in Madoa in about 1860. In 1898, on Ulawa, out of an estimated population of 1000 people there were 16 baptisms, 245 Christians, and 437 people under instruction. By 1900, four villages were still heathen on Ulawa, with 351 Christians out of a total population of 700 people.

The Melanesian Mission was well aware of the powerful example provided by Clement's church. Even before its completion, the missionary publications praised the church and its creator continuously. Thus, in a special issue of the *Southern Cross Log* (IV(45):30, 1898) we read:

> Undoubtedly what will prove to be one great factor in the final establishment of Christianity in Ulawa will be found in the completion and consecration of the church at Madoa. Already its fame is established, and Christians regard it as a marvellous instance of what can be done under the influence of the Holy Spirit, and heathens are confirmed in their opinion that some great spirit must be helping those who adopt the new way. We trust that by the end of 1899 the church will be all ready for consecration, with its iron roof on, and the stone pavement finished in the chancel.

And again, written about Ulawa in 1899, for an English audience:

> The island is now largely Christian, more than half the people probably attending the five schools. The Rev. C. Marau is a great power, and has immense influence throughout the whole island. He has built a wonderful coral church, after the pattern of St Barnabas', Norfolk Island. This is the finest building in the Solomon Islands, and reflects great credit upon the native Christians who built it. He has also composed chants and hymns for the services. (*SCL* V(53):34-5, Nov 1899)

When the Christians of Su'uholo village asked Clement to stay on Ulawa and build a

church for them he agreed, thereby delaying his own ordination. As Awdry (1903:105) reported:

> It has been very uphill work, and the small island is still not entirely Christian, but there are six schools, and in 1901 a really remarkably fine church was opened, built under Clement's direction, of which the people are justifiably very proud. Clement would have been ordained priest by now if he could have been spared to go away to Norfolk Island for the necessary study, but when his own church was finished the people of a neighbouring village implored him to stay a little longer and help them to build a similar one and he consented. There is a great wave of church building in the islands now, and the people care very much to have them beautiful, and will often build the churches of coral, or even of stone (although their own houses are woven of wicker-work), and they inlay the ends of the seats, lecterns, etc., with mother of pearl or shell, as they used to do their great war canoes.

The historian of the Melanesian Mission, David Hilliard (1978:173) commented:

> When completed in 1901, after seven years' work by the people of the village, it was the first building of its kind in the Solomons and the most elaborate yet built in the island diocese. Like the Patteson Memorial Chapel at Norfolk Island, it had a semi-circular apse and was dedicated to St. Barnabas. Its fame spread throughout the south-east Solomons, and its example was followed by Christian communities elsewhere in Ulawa and south Malaita.

The expensive corrugated iron roof on the church had been the special ambition of Clement Marau, and his success in achieving this, with the help of the money from the sale of the Auckland canoe, greatly enhanced his personal prestige. Clement's difficulties in obtaining suitable tools and new materials illustrates how some materials from the outside world only reached Melanesia at great personal and financial cost. The dealings around these materials illuminate the workings of an early colonial society. On a wider scale, the corrugated iron roof at Madoa can be seen as one early example of the introduction of corrugated iron into a Pacific economy. The rapid spread of corrugated iron as a long-lasting material conferring high status soon became familiar across the Pacific.

But so much of this development here at Ulawa depended on the personal status of Clement Marau. As Hilliard (1978:173) commented:

> Marau's disgrace in 1907 for visiting village women at night after the evening bell had rung and his punishment of those who knew of his adulteries caused the once-flourishing Ulawa church to almost disintegrate in a resurgence of pagan customs and religious rites.

THE MELANESIAN MISSION AND SOLOMON ISLANDS CULTURES

The Melanesian Mission was known for its relaxed permissive attitude towards certain aspects of traditional Melanesian culture. There was no blanket prohibition of betel nut chewing, smoking, traditional dancing, mourning rites, Christian attendance at pagan feasts or the payment of bride price. Also the Mission made explicit provision for the Christian blessing of canoes, nets, houses, gardens and other customary activities (Hilliard 1978:196-197). Many of the earlier church buildings were constructed to the form of traditional custom houses with

some of their decorations continued. Some active encouragement was given by European missionaries to the retention of native handicrafts and their use in the decoration of village churches. The continued use of cone shell and nautilus shell inlay on introduced forms including church furniture and equipment was part of this wider permissive attitude.

In his new church, Clement planned to apply shell inlay to the ends of the pews, the chalices, the lectern and the credence or Holy Table (*SCL* IV(43):10, Nov 1898). After his 1924 fieldwork, Ivens (1927:48) later reported,

> The church at Mwado'a has its altar and reredos inlaid with 5,000 pieces of cut pearl nautilus shell. The dove (with lambent rays) on the top of the reredos, a triumph of inlaying work, was done by Robert Marau [a son of Clement].

This permissive and ambivalent attitude of the Melanesian Mission towards traditional Ulawan culture is also apparent in the building and disposal of the Auckland Museum Ulawa canoe. This small canoe embodied several different meanings for the groups of people involved in its manufacture and subsequent life-history. For Clement Marau and the Ulawa people who made it, the canoe was a means to show outsiders something of the rich symbolism of their traditional culture. It was a symbol of the best effort and best skills their culture could muster. However, for Clement Marau and the Ulawa Christians, it was also a means to a greater end, one way available for them to raise money for their church roof. As such, it was already being considered as a commodity, made expressly to sell to the highest bidder. When seen within the context of Ulawan society, this shift to a canoe as a commodity was not such a huge step as might be imagined.

As traditional exporters of full-size canoes to other areas of the south-east Solomons, Ulawans were accustomed to the idea of trading and selling their new canoes. For Clement himself, the sale of curios as an important source of income was not a new idea, as he had already raised the money for his bride-price by learning to do shell inlay work in Ulawan style for sale. After his visit to Ulawa in 1892, Montgomery (1908:218) commented:

> Ulawa is famous for its bowls and model canoes and woodwork inlaid with mother-of-pearl. The ship [*Southern Cross*] does not buy anything on Sunday; but on Monday morning as soon as it was light the bargaining was very brisk, and bowls and tobacco changed hands to a very large extent.

This trade in artefacts shows that the Ulawa people were used to supplying demand from outsiders for their artworks. They had already realised the value of their artworks as something that outsiders valued and coveted. Clement simply expanded the idea of producing art commodities to include a full-size canoe. Ivens sometimes claimed that this canoe had been built expressly for sale at his, Ivens', suggestion. Regardless of whether it was Marau or Ivens who initiated the project, the question is raised regarding the amount of shell inlay on the canoe. If this was a conscious attempt to make a better one than ever seen before, then it may well have been more elaborately decorated than usual.

Certainly Ivens promoted the canoe as, "perfect—such a good specimen has never been offered for sale before & the people say that they never turned out such a piece of work before." Thus, for the missionaries, this canoe was the best ever made and the best ever offered for sale. As such, they regarded it as a perfect example of the power of Christianity to motivate its converts for a better life.

For the Auckland Museum of the time, this canoe sufficed as an example of a traditional

bonito canoe. As will be seen below, the museum rejected the chance of obtaining another canoe from Ulawa because it already had this as an example.

ULAWAN CANOES AND BOWLS AS COMMODITIES

Both the Madoa Church and the Auckland Museum bonito canoe were moments or episodes within an ongoing production of artefacts on Ulawa which included objects made for local use, objects made expressly for sale, and objects which moved from local use to sale. On many of these, shell inlay with conus or nautilus shell continued and developed as a hallmark of Ulawan and Solomon Islands origin.

There are indications that during the later nineteenth century, the art of shell inlay had been changing from a specialised, ritually prescribed technique to a democratised practice open to anybody with the patience and skill. Ivens (1927:472) described how on Ulawa in former times, a man who was engaged in inlaying a *la'o* canoe would stay in the canoe house until his work was finished. If he had to go outside, he wrapped himself in a pandanus umbrella to conceal his identity. The ostensible explanation given for this was the need to keep the sun off him, otherwise it would cause the parinarium putty to soften and fail to fix the *la'o* shell inlays into place. And no women were allowed to see the decorated canoes used in bonito fishing. By the 1880s this restricted access to the shell inlay craft must have been softening, when Clement Marau, an outsider, was allowed to inlay bowls for sale. By 1897, the inlay on the Auckland Museum bonito canoe was "done by the people as a whole". By 1904, Ivens was advertising his skill at inlaying and offering to add inlay as required. And by 1925 as will be shown below, an Ulawan canoe builder was offering to add inlay purely for effect to meet European buyers' preferences.

Fig. 22. Large food serving bowl (AM 13006) of *kere-ni-kuau* type inlaid with nautilus and cone shell, 187 cm long. Ulawa. Purchased from Melanesian Mission in 1916. Photo: Auckland Museum.

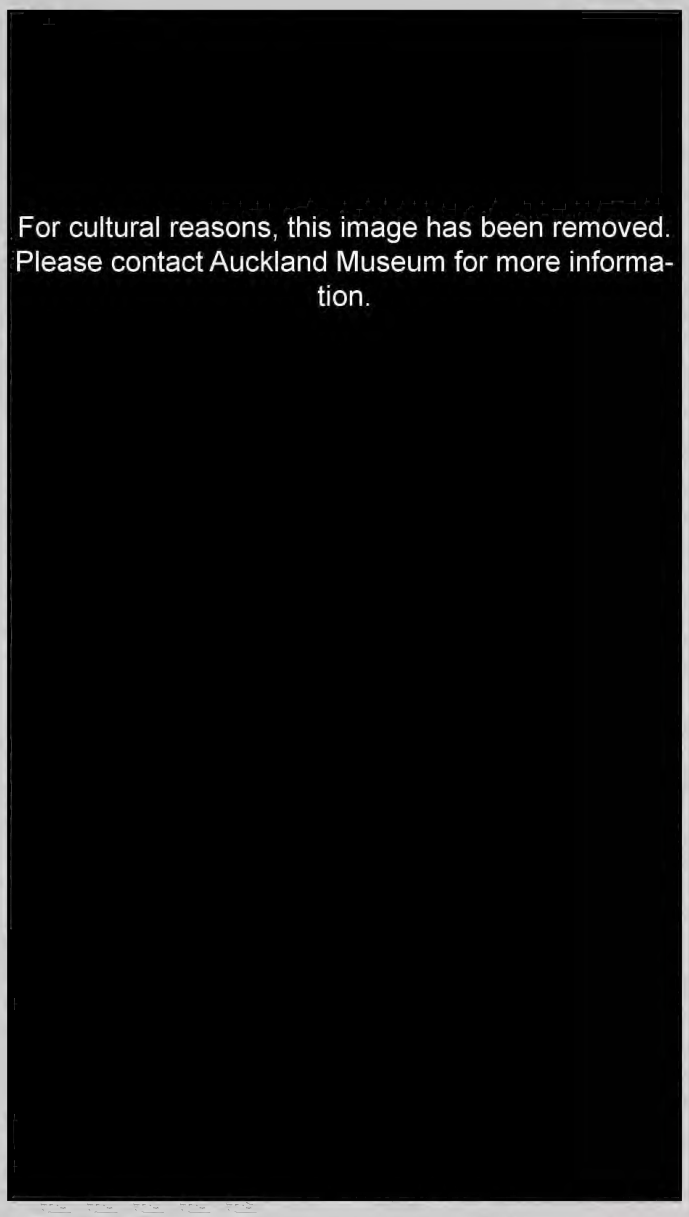

Fig. 23. Enlarged traditional comb from Tulagi, south-east Solomons (AM 13628) decorated with symbols of cross and church architecture. Photo: Auckland Museum.

Melanesian Mission influence had a strong effect with regard to the acceptance and encouragement of shell inlay on all these categories of objects, whether canoes, bowls (Fig. 22) or church furniture. This church encouragement of inlay and the influence of Christian symbols also penetrated back into the production of traditional forms of artefacts. Examples of this are a Solomon Islands wooden comb (Fig. 23) with shell inlay set among elements of church architecture, or many objects featuring a cross as decoration and sign of the owner's conversion to Christianity.

Clement Marau's production and sale of Ulawa-style inlaid bowls to raise his bride-price money leads to the intriguing question of how many inlaid bowls collected from Ulawa during the 1880s and 1890s were actually made by a Merlav man, that is Clement Marau, living on Ulawa.

In a very revealing letter, Ivens (Ivens to Cheeesman, 11 Feb 1904, Auckland Museum files) shows how the tastes of European purchasers began to influence the production of commercialised artefacts on Ulawa. He also naively indicated the extent of his own involvement in the manufacture and sale of curios from Ulawa. Cheeseman had recently declined to purchase an Ulawa bowl because he thought that it was too plain to arouse the interest of the Auckland public. Ivens writes:

> It was a revelation to me re the public's taste ... Your remarks re inlaying of bowls has set me to work—I have here two more large bowls given by Ulawa people for sale to provide money for roofing their church. I am having them inlaid here [at St Barnabas, Norfolk Island] now by Ulawa men—the actual shell to inlay each costs me nearly a pound to buy. One of them might possibly suit you when it has been inlaid; the most likely one is over 7ft. in length including handles ... You may take my assurance that both of these will be well inlaid

> for I myself am no novice in the art of inlaying. One must I suppose put a price on the bowls so that you may have some basis to work on—£5 or £6 would to my mind represent a fair price. They must be sold and I shall take them myself to NZ in November if I cannot find a purchaser.

Comins and Ivens had a strong influence on the building of the Madoa church and the Auckland canoe. Ivens' letter quoted above gives some indication of their wider influence, especially with regard to the acceptance and encouragement of shell inlay on objects made for sale to outsiders.

In his review of the significance of the Melanesian Mission for museum artefact collections, Stanley (1994:36) suggested that new syncretic objects, often featuring shell inlay and Christian symbolism, had a central importance for the Mission in bridging the old and new orders and providing legitimation for the new. He sees missionary collecting of these objects as a sign of searching for cultural continuity. All these motivations are no doubt true but this present study also indicates a more practical purpose behind missionary promotion of distinctive shell-inlaid objects. This was the need to raise money for the mission and the need of individual poorly-paid missionaries to raise money for themselves and their families, a point also made by Stanley. Stanley hesitates to suggest that some of these syncretic objects may have been collected with the thought of future missionary exhibitions in mind, but in view of the role of Ivens in artefact production documented here it may not even be too far fetched to suppose that some objects were actually manufactured with this purpose in mind.

For the western Solomons, Waite (1999) has demonstrated how the figurehead or *nguzunguzu* from traditional headhunting canoes has been tamed and made into a symbol of the modern Solomon Islands. In the south-east Solomons, the same role has been assumed by the ceremonial bowl with black surface and shell inlay that has made the transition to modern national symbol (Davenport 1997; Mead 1979). This study has perhaps revealed some of the Melanesian Mission's influence on this transition.

THE PERSISTENCE OF THE ULAWA CANOE

As was noted above, the last pagan canoe rituals and initiations took place in Madoa in about 1860. At Madoa in 1924, Ivens (1927:xvii) found "only one elder who had known the old days". Two other villages on Ulawa had held *malaohu* feasts in the early 1920s and Ivens (1927:132) expected that these two villages might still hold them again in the future. Of the 900 people living in nine villages on Ulawa by 1924, there were fewer than 40 men over 50 years of age, and only three villages were still heathen. Pessimistically, Ivens (1927:146) described one of the few old men making a bonito canoe at Sa'a on Malaita in 1925, expecting that, "with the passing of the bonito catching the zest for canoe building will pass too".

In 1925 on his return from his last fieldwork in Ulawa, Ivens wrote to Cheeseman in a letter that reveals the changing attitudes towards canoe rituals and the commodification of their associated artforms on Ulawa:

> A native on Ulawa has a large inlaid canoe for sale—the length is 24 feet—it is a full-sized three man canoe (seating four). The inlay work is of nautilus shell set in patterns representing frigate birds, three on each side with conventional designs in between—these are on the top plank. Sections of cone shell, white semicircular, run the length of the canoe on both sides and also across the upraised stem and stern. The usual streamers of strips of the umbrella palm dyed red adorn the stem and the stern. The canoe is fitted out with paddles. It is a good specimen of the inlaid Ulawa canoe. You have a small one

> man canoe in the museum from Ulawa, but the decoration is of nautilus shell only. This one has the la'o cone shell in addition. For the one in the museum £12 was paid. The price asked for the three man canoe is £28 to £30. I promised the man that I would make enquiries about the sale. The Southern Cross could pick it up next year and I am sure Captain Burgess would see to its being carried safely. Payment would have to be made to the owner—partly in money and partly in tobacco. This could easily be arranged. The native priest in charge of Ulawa, Rev. Martin Marau [son of Clement], would act as a go-between for the Captain. The agreement with the owner was that I was to write to Martin Marau and inform him as to whether a sale had been made. In this event the owner was to put certain finishing touches to the inlaying, getting in as much shell as possible so as to make the canoe look really well—for as I told him canoes sell by reason of the inlay rather than of their sea-worthiness where white people are concerned... As you will realise, the opportunities for securing such things grow less and less every year—the natives are ceasing to produce such things. When I saw the canoe at Ulawa I realised that here was a chance to procure a really good article. (Ivens to Cheeseman, 18 Sep 1925, Auckland Museum files)

Obviously, by this time the message about the preference of European buyers for more elaborate shell inlay had become a standard part of the arrangement in producing objects for sale to collectors. Sadly, Auckland Museum declined to purchase this larger Ulawa canoe, commenting that it already had "the type at least represented" (Cheeseman to Ivens, 20 Oct 1925, Auckland Museum files).

Some published accounts describe the continuation of the *malaohu* or *maraufu* initiation ceremonies in the south-east Solomons into the twentieth century. This implies that bonito canoes were still active for these ceremonies to be complete. An initiation ceremony was held at Natagera on Santa Ana in the late 1920s (Mead 1973a). Bernatzik (1935:Fig. 14) figures an "enormous festal dish, modelled on the bonito fishing canoe, used for the initiation festival at Ngora-Ngora", indicating that an initiation ceremony for young boys took place at Ngorangora on the northern tip of Ulawa in 1932 or thereabouts.

Using photographs taken by American military visitors to elicit participants' memories, Mead (1973a) described the last *malaohu* bonito initiation held in the village of Gupuna on Santa Ana in 1943. Bonito canoes were involved in these ceremonies and some are visible in the photographs taken at the time.

Davenport reported (1990:124, note 5) that the only fleet of specialised bonito canoes still operating in the 1960s in the eastern Solomon Islands, according to the practice of the traditional religion, was maintained by the important men of one group on Santa Catalina.

Writing of Star Harbour, San Cristobal, in the period of 1970-1971, Mead (1973b:22) was pessimistic about the future of the bonito canoe. He noted only two functioning bonito canoes in Santa Ana and about ten in Santa Catalina, but none on the mainland of San Cristobal. He believed that their days were numbered, because the foundation of the bonito canoe cult had been undercut by conversion to Christianity and because bonito can be caught more efficiently from a dugout canoe powered by an outboard motor.

However, by the 1970s bonito canoes had still not become extinct on Ulawa, where they were seen by Pendergrast in 1973 and Hendren (1976:152-153) in the early 1970s. Perhaps a similar situation developed here on Ulawa as described by Davenport (1990:100) on Santa Catalina in the 1960s. There, devout Christians could still build and maintain ancestor memorial bonito canoes for catching bonito to eat, but they must avoid all associations with the bonito canoes dedicated to tutelary deities, as still used by pagan islanders.

CONCLUSION

Many strands have been entwined in this study. It now remains to separate some of these aspects and assess what has been added to the documentation and understanding of Ulawan history and culture.

At the most obvious level, by adding a third Ulawa canoe to the corpus of museum-held examples, this study has provided an opportunity to add further information to published descriptions of Ulawa bonito canoes, with regard to basic construction and decorations. With the aid of Ivens' letter, it has also been possible to increase our understanding of the symbolism of Ulawa bonito canoes. Although very similar in construction and decoration to the bonito canoes from Santa Ana, Santa Catalina and San Cristobal, this Ulawa canoe is distinguished by the darker colour of its planks and the richness of its shell-inlay decorations along the mid-sides of the canoe, especially the frontal frigate birds and the *akalo ni matawa.* Whether these extra shell inlay figures are a normal feature of Ulawa bonito canoes or a sign of the special purpose of this particular canoe is a moot point.

Parallel to the construction and symbolism of the Ulawa bonito canoe, this study documents the building of an important new Pacific Island church that had a pivotal role in furthering the development of church building in this part of the Pacific. Therefore, a better understanding of the contexts and motivations involved in the building of the Madoa church is critical for future studies of the history of northern Vanuatu and Solomon Islands church architecture. Beattie's magnificent photographic documentation of the Madoa church and many other smaller local church buildings throughout the area deserves to be better known and better utilised.

By concentrating on the critical case of the Madoa church, some appreciation can be gained of the processes of introduction of new tools, new technologies and new materials into this part of the Pacific. Coral blocks sawn with a rusty broken cross-cut saw, stones dressed for the chancel floor using large numbers of steel axes instead of more appropriate masons' hammers, mortised joints, a builder's level contrived of split bamboo, and the people's excitement at the efficiency of an augur, all illustrate the intensive labour and individual learning and adjustments involved in the introduction of new technologies.

On a socio-political level, by expanding the analysis beyond the actual artefacts of church and canoes into the wider social context, this study has been able to provide a more detailed and concrete description of the introduction of Christianity to Ulawa than was previously available. By examining the socio-political context of production for both the canoe and the church, the 'baggage of the transcultural encounter' in which these two artefacts were created has been 'unpacked' to a greater extent. This clarification raises some interesting questions for the notion of artefactual authenticity.

These questions of authenticity need to be considered against the background of the commodification of artefacts and the early development of tourist art in Ulawa. Several years before the Auckland bonito canoe was built, a trade in model canoes and inlaid bowls had already developed. The Auckland Museum wanted to regard their bonito canoe as a straightforward unproblematic example of an Ulawan bonito canoe. However, the analysis pursued here has highlighted some of the traces of the complex transcultural encounter inscribed in this artefact. While the museum thought that it could treat this canoe as a traditional artefact, in fact both the 'traditional' canoe and the 'introduced' church were created in very similar situations. Even though European influence may not be obvious in the canoe at first sight, it is there, embedded in the object.

For those seeking a pure 'authentic' Ulawan bonito canoe, the role of the Melanesian Mission in the creation of this one would be seen as a complication better forgotten. For these seekers of

authenticity, the notion would become even more problematic when the hands-on involvement in artefact production by Rev. Clement Marau, and perhaps even Rev. Walter Ivens, has to be taken into account. However, by tracking the development of artefact commodity production in one small Pacific island, a deeper appreciation of the richness and complexity of the situation of production is now possible. In effect, the canoe has now gained a more 'authentic' history, and a history within which the Melanesian Mission's role is better understood. Consequently, this study provides an early example of the role of a Christian mission as a major player in the commodification of artefacts, a role repeated in many other areas of the modern Pacific. And even further in the case of Ulawa and the south-east Solomons generally, this study has illuminated the role of the Melanesian Mission in the development of inlaid bowls as another national symbol for the Solomon Islands, matching the comparable development of *nguzunguzu* canoe figureheads as a national symbol from the western Solomons.

From one perspective, this canoe can be regarded as an example of those numerous objects collected during the heyday of ethnological collecting in the late nineteenth and early twentieth centuries, which on closer research now turn out to be replicas produced for sale at the time of their manufacture. However, it must be remembered that as artefacts move through space and time between cultures, they have the potential to shift and slide between categories, regarded sometimes as artefact, sometimes as art, sometimes as replica, and sometimes as commodity.

In view of Davenport's (1968:22) observation that sacred bonito canoes and their canoe houses are the main locus where "the secular domain of man intersects with the sacred domain of the deities", it is tempting to treat church buildings also in this light. Churches then replaced bonito canoes and canoe houses as the main locus representing man's relationship to his new 'tutelary deity', the Christian god. Such a suggested simple replacement is probably too convenient for a very complicated process. Any hypothesis along these lines for Ulawa would need a systematic analysis of the passing of canoe houses and custom houses village by village as Christianity progressed. Did bonito canoes and canoe houses pass away at the same time as the church arrived or earlier or later? Why did Madoa cease holding its *malaohu* ceremonies so early? Why, how and where has the bonito canoe persisted in parts of Ulawa?

Acknowledgements. I thank Mick Pendergrast for information supplied and for his comments on the text. Janet Davidson, Nick Stanley and Deborah Waite have all supplied helpful comments.

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NOTES

1. *The Southern Cross Log* (*SCL*) was first published as a monthly journal in Auckland as a New Zealand and Australia edition starting in 1895 and later also as an English edition starting in 1900. Because of the editorial design of this publication, it is not always possible to determine the author of particular contributions. Consequently some quotes used here can only be referenced to the SCL. The *Southern Cross Log* was named after the mission ship owned by the Melanesian Mission of the Anglican Church. The Melanesian Mission had moved its headquarters to Norfolk Island in 1867, but the mission ship continued to be based and serviced in Auckland. From Auckland, the *Southern Cross* made regular annual voyages of about five month's duration to visit all of the mission's stations throughout the Melanesia islands.

2. John Watt Beattie (1859-1930) was a prominent photographer of portraits and landscape based in Hobart, Tasmania. In 1906 the Bishop of Melanesia, the Right Rev. Dr Wilson invited him to travel on the Melanesian Mission steamer, the *Southern Cross*, on its annual five months voyage around Vanuatu and the Solomon Islands. Beattie exposed about 1,300 plates on this voyage and kept a diary of the trip. Virtually all of these negatives were purchased by Auckland Museum in 1933, three years after the photographer's death.

In his diary of the 1906 *Southern Cross* voyage, Beattie (Mss RS 29/3, p.24, Royal Society of Tasmania) describes their arrival at 6 am on Wednesday 3 October off Madoa on Ulawa, "where Rev. Clement Marau the foremost clergyman of the Mission resides—he is a Melanesian". An hour later, Beattie got ashore, "The landing was very rocky, and it looked dangerous to look behind and see the curling white breakers coming on as though they would overwhelm you. The Bishop invariably takes the steer oar, and is an expert boatman. Madoa is a large village, very clean, with a very fine church, stone walls with galvanised iron roof. I got one or two characteristic photographs and then back to the ship again". The ship called at Madoa again on Monday 29 October for two hours and Beattie was able to take more photographs. Next day they called at other Ulawa stations, starting with Lenga, then Marata and finally Ahia, along the coast to the south-east. At Ahia, Beattie met many people who had not yet become Christians; "they remain in their old time ways and are very dirty and smelly in consequence. Still they are interesting ... They have a very fine and large gamal [custom house] here, the best I have seen yet. There are many carvings of a somewhat 'loud' order, fine food bowls, and other native manufactures useful and ornamental. I got the gamal with some of the occupants."

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MARINE BIOTA OF PARENGARENGA HARBOUR, NORTHLAND, NEW ZEALAND

BRUCE W. HAYWARD, A. BRETT STEPHENSON, MARGARET S. MORLEY, WILMA M. BLOM, HUGH R. GRENFELL, FRED J. BROOK, JENNY L. RILEY, FIONA THOMPSON AND JESSICA J. HAYWARD

Abstract. Four hundred and fifty-two species of marine fauna are recorded from Parengarenga, New Zealand's northernmost harbour. This tally comprises 266 molluscs (13 chitons, 179 gastropods, 73 bivalves, 2 cephalopods), 86 crustaceans (including 33 crabs and shrimps, 22 amphipods, 16 isopods, 7 barnacles), 50 polychaete worms, 32 fish, 8 echinoderms and 10 species from other groups.

The fauna in Parengarenga's subtidal channels exhibits a zonation corresponding to decreasing salinity and wave exposure from the harbour mouth to the headwaters. The slightly deeper lower harbour channels have a benthic faunal association characterised by four common bivalves (*Tawera spissa, Felaniella zelandica, Myadora striata, Gari stangeri*), hermit crabs, the whelk *Cominella quoyana,* polychaete *Owenia fusiformis,* and amphipod *Proharpinia.* The subtidal upper harbour faunal association is characterised by three common bivalves (*Nucula hartvigiana, Austrovenus stutchburyi, Paphies australis*), whelks *Cominella adspersa* and *C. glandiformis,* pillbox crab *Halicarcinus varius,* cumacean *Cyclaspis thomsoni,* and a wide diversity of amphipods and polychaetes.

The intertidal flats are dominated by *Zostera* seagrass meadows with smaller areas of bare quartz sand near the harbour entrance. Around the upper reaches of the harbour there is extensive mangrove forest between mid and high tide levels, with salt marsh and minor salt meadow mostly above mean high tide. Extensive areas of intertidal *Zostera*-covered quartz sand flats bathed in clear, warm water and periodically influenced by eddies from the East Auckland Current provide an unusual habitat for New Zealand. It is home to low numbers of subtropical gastropods, seldom seen intertidally or on sand elsewhere in the country (e.g. *Charonia lampas, Cymatium exaratum, Cymatium parthenopeum, Sassia parkinsonia, Ranella australasia, Cabestana spengleri, Conus lischkeanus, Polinices simiae, Natica migratoria, Bullina lineata* and *Hydatina physis*). Many brightly coloured nudibranchs live at and below low tide at Paua, Te Hapua and Ngatehe Point.

KEYWORDS: New Zealand; Northland; Parengarenga Harbour; biogeography; subtidal channel benthic associations; intertidal communities; *Zostera* flats; nudibranchs; warm-water molluscs.

INTRODUCTION

OBJECTIVES

The objectives of this study were to compile an inventory of the macrofauna (>1 mm) of New Zealand's northernmost harbour for biogeographic purposes and to document and map the

intertidal and subtidal marine communities of one of New Zealand's more pristine harbours for comparison with other northern harbour ecosystems that have been heavily impacted by human activities (e.g. Waitemata Harbour). It was also hoped that the present study would provide a snapshot of Parengarenga Harbour in the mid 1990s as a benchmark for the documentation of future natural or human-induced changes.

LOCATION AND DESCRIPTION

Parengarenga Harbour (latitude 34°30'S, longitude 173°58'E), on the east coast just south of North Cape (Fig. 1), is the northernmost harbour in New Zealand. The harbour is a drowned valley system with many meandering branches, that were flooded by rising sea level 6,500-7,000 years ago, following the end of the Last Glaciation. The harbour is sheltered from the

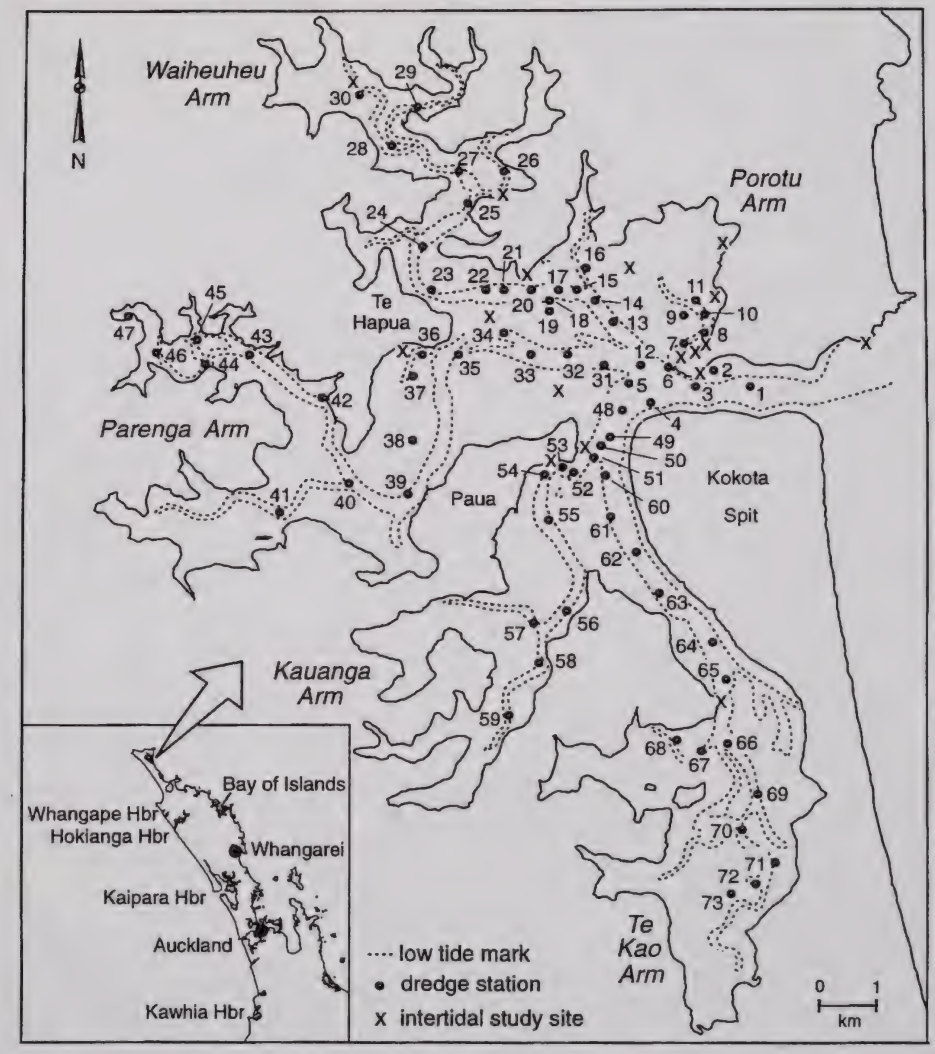

Fig. 1. Location of subtidal (dredge) and intertidal benthos sampling stations in Parengarenga Harbour, Northland.

Pacific Ocean by a large Pleistocene and Holocene sand dune barrier (Kokota Spit) of pure white quartz sand.

Parengarenga Harbour is in a relatively remote area with little evidence of pollution resulting from human activities. The harbour is surrounded by gently rolling farmed grassland (southern and western catchments), scrub regenerating to forest (northern catchment), and unvegetated or pine-forested sand dunes (eastern barrier). There are two small centres of human occupation—at Te Hapua on the harbour edge and at Te Kao, in the southern catchment. There is no evidence of artificial reclamation or mangrove or seagrass clearance. The extensive wooden structures of an oyster farm (established in the 1970s) are present intertidally on the northern Waiheuheu Arm. Sand mining at the northern end of Kokota Spit in the vicinity of the harbour entrance has been carried out for some decades and has undoubtedly resulted in geomorphic changes.

PREVIOUS WORK

The only previously published observations on the biota of Parengarenga is Gardner (1978), who recorded 53 gastropod and 19 bivalve species dredged from the main channel between Dog Island and the harbour entrance. He dredged to determine the abundance and extent of the newly-recorded Australian bivalve *Myochama tasmanica* (Powell 1974, Gardner 1976).

There have been no previous ecological surveys of the biota of Parengarenga Harbour, although there have been several previous studies on the ecological distribution of the bottom-dwelling biota of other harbours and estuaries around northern New Zealand. These have mainly dealt with the larger harbours—Manukau Harbour (Grange 1979, 1982; Henriques 1980) and Waitemata Harbour (Powell 1937; Hayward *et al.* 1997, 1999), although Grace (1966) and Brook *et al.* (1981) documented the subtidal fauna of the smaller Whangateau and Tutukaka Harbours on Northland's east coast and Hayward & Hollis (1993) and Hayward *et al.* (1995) described the fauna of Waimamaku estuary and Whangape Harbour on Northland's west coast.

METHODS

This survey was undertaken during two Auckland Institute and Museum field trips in October 1992 and March 1996.

DREDGING

Samples (Appendix 1) were collected using a small, 10-litre capacity bucket dredge, hand-hauled from a 4 m aluminium dinghy powered by a 18 horse-power outboard motor. The sediment was sampled to a depth of 50-100 mm. The sediment grain-size was visually estimated and recorded, washed over a 2 mm sieve in 1992 and a 1 mm sieve in 1996 to remove mud and sand and then all live organisms were picked out, identified, counted and mostly returned to the sea. The finer mesh size used in 1996 resulted in more comprehensive sampling of small organisms such as amphipods, isopods and smaller polychaete worms.

INTERTIDAL AND SUBTIDAL OBSERVATIONS

Shoreline searches in the range of habitats and niches present were undertaken at numerous locations (Appendix 1) during spring low tides. Species encountered live or dead were separately recorded. Low-tide snorkelling was undertaken by MSM at several locations (Appendix 1) to search for subtidally-restricted organisms. Descriptions of biotas on subtidal rocky reefs at

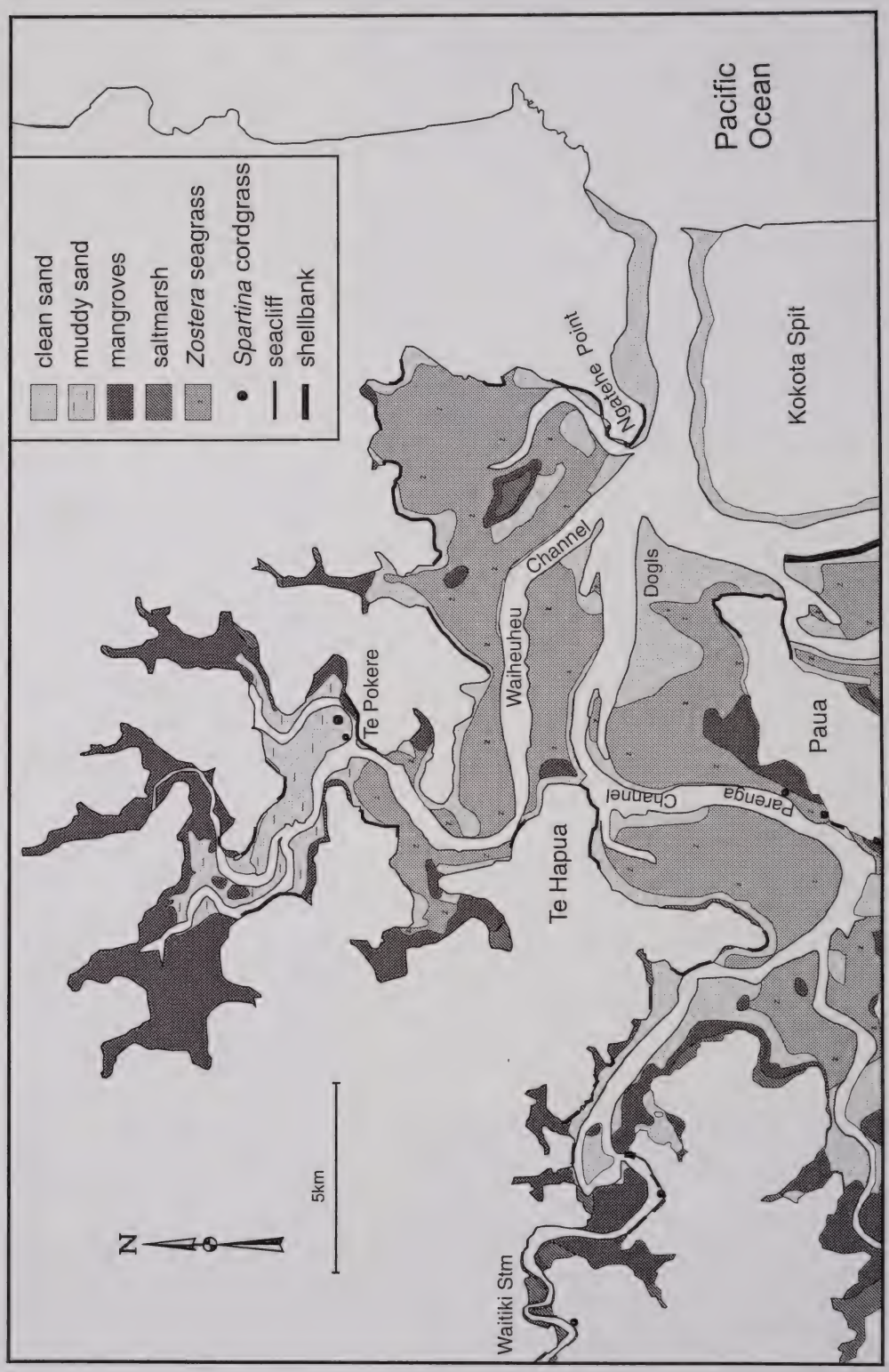

Fig. 2. Map of the major intertidal communities in Parengarenga Harbour.

Pacific Ocean
Kokota
Spit
Te Kao Channel
Kauanga Channel
Paua
Te Kao Arm
5km
N
clean sand
muddy sand
mangroves
salt marsh
Zostera seagrass
Spartina cordgrass
seacliff
shell bank

Ngatehe Point and Akatere Point are based on SCUBA observations made in December 1990 by FJB.

MAPPING INTERTIDAL COMMUNITIES

All intertidal areas of the harbour were either visited at low tide on foot or by boat or viewed from a nearby hillside. The intertidal zone was classified into eight easily distinguished units for mapping in the field (Fig. 2). The exact boundaries of these units were later verified and corrected using recent colour aerial photographs.

SPECIMENS

Where the identification was uncertain, specimens were preserved and brought back to the Auckland War Memorial Museum (AK) for study. We also collected voucher specimens of most taxa for the museum's marine collections.

SEDIMENTS

Detailed sediment grain-size analysis and mapping was not undertaken during this study, but Parengarenga Harbour is renown for its large expanses of clean quartz sand. This fine to medium sand forms Kokota Spit but also underlies almost all the subtidal and intertidal parts of the harbour. Intertidally the sand flats are muddy sand in the upper half of Waiheuheu Arm, where mud washes in from the northern catchment. Subtidally the sandy substrate of the channels is also mixed with mud throughout most of the length of Waiheuheu Arm and the northern branch (Waitiki Channel) of Parenga Arm. Intertidal areas and subtidal channels in the southern half of Parengarenga Harbour are generally cleaner than in the north, reflecting the difference in rock types and weathering between their catchments.

Sediment in the subtidal channels is always quartz sand, but in many places it is shelly or slightly shelly (mostly cockle shells). Cockle shells have been concentrated by tidal currents and waves to form elongate intertidal shell banks alongside Te Kao channel and in the southern branch of Parenga Arm (Fig. 2). Gravelly sand was encountered off Paua wharf and Ngatehe Point (stns. 53 and 7) adjacent to intertidal areas of exposed rock.

ECOLOGICAL DISTRIBUTION PATTERNS OF SUBTIDAL BENTHIC ORGANISMS

SUBTIDAL CHANNEL FAUNA

All the subtidal areas of Parengarenga Harbour are channels. The depth of these channels increases from 0-4 m to 3-7 m towards the harbour entrance. The deepest part of the harbour (25 m) is a current-scoured hole in the harbour end of the entrance channel (stn. 3). A second tidal-current-scoured hole (10 m deep) occurs in the narrow, sharp bend of Kauanga Arm adjacent to Paua wharf (stn. 53). Subtidal areas cover less than 25% of the harbour, but support nearly 50% of the harbour's faunal diversity.

One hundred and forty-seven species have been recorded live in or on the sand or muddy sand floor of the subtidal channels and an additional 36 species have been recorded dead and presumably most of these also live in low numbers in this habitat. The most abundant macro-organisms living in the subtidal channels are 10 species of polychaete worms, six species of amphipod (Appendix 2) and the bivalves *Austrovenus stutchburyi, Felaniella zelandica,* and *Nucula hartvigiana.* The most diverse groups living subtidally are polychaetes (40 species), amphipods and gastropods (21 species each), bivalves (19 species), crabs (10 species), and isopods (nine

species). Most of the dead records are of rare or small gastropods (26 species).

A transect of dredge stations taken up each arm of Parengarenga Harbour from the harbour mouth to near the headwaters resulted in the recognition of distinct lower and upper harbour faunal associations (Fig. 3). In the two northern arms there is a near-barren zone (stns. 24-26, 35-39) between these associations containing few live macro-organisms.

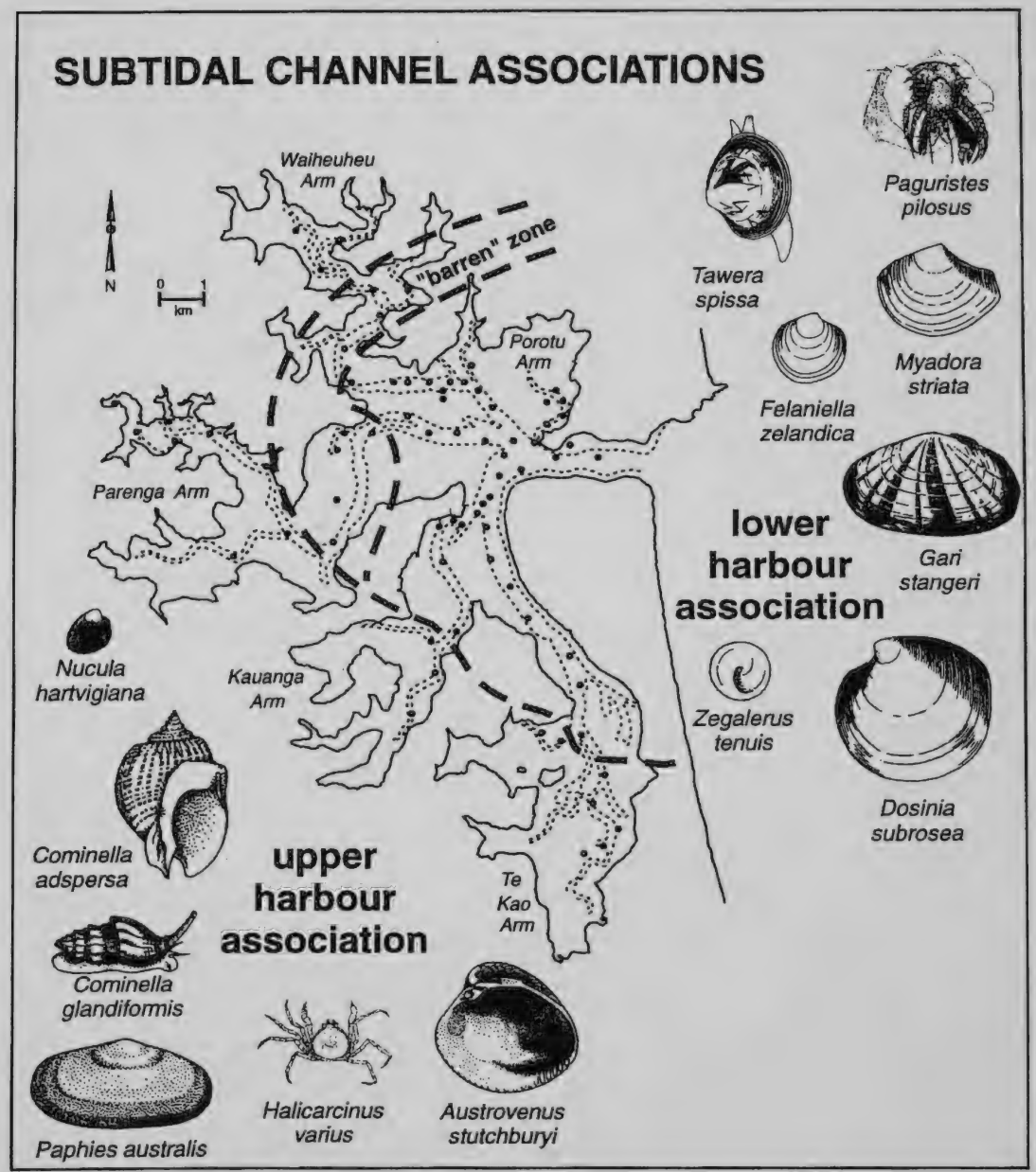

Fig. 3. Map showing the distribution and dominant biota of the major subtidal associations in Parengarenga Harbour channels. Drawings by MSM and ABS.

Lower harbour association (Tawera spissa-Felaniella zelandica)

This association extends up the subtidal channel of each arm from a "barren" zone in the harbour mouth where there is coarse sand swept clean by strong tidal currents (Fig. 3). It extends further up the Te Kao Arm (6 km) than the others, and its shortest penetration is up the Parenga Arm (2.5 km).

The fauna is characterised by variable combinations of bivalves, in decreasing order of abundance—*Tawera spissa* (60% of stations), *Felaniella zelandica* (60%), *Myadora striata* (33%), *Gari stangeri* (30%), *Soletellina nitida* (28%), *Dosinia subrosea* (20%), *Pleuromeris zelandica* (16%), *Myochama tasmanica* (13%) and *Ruditapes largillierti* (13%), together with the subtidal hermit crab *Paguristes pilosus* (28%), swimming crab *Liocarcinus corrugatus* (30%), the scavenging whelk *Cominella quoyana* (30%), and polychaete *Owenia fusiformis* (25%).

The majority of Parengarenga's chitons (nine species) and the saucer limpet *Zegalerus tenuis* are found in low numbers on shells in this association.

Numerous amphipods (especially *Proharpinia* sp., *Trichophoxus chelatus, Waipirophoxus australis,* and *Parwaldeckia thomsoni*), and only a few isopods, live in this association. Thirty-four species of polychaetes have been recorded (especially *Owenia fusiformis,* nereids, maldanids, *Aglaophamus macroura, Armandia maculata,* and *Axiothella quadrimaculata*). Unusually frequent in this association are the sand-dwelling lancelets *Epigonichthys benhami* and *E. hectori,* tommy fish *Limichthys polyactis* and short-finned worm-eel *Muraenichthys australis.* Many other species are present, represented by relatively low numbers (Appendix 2).

Other fish common in subtidal channels include kahawai (*Arripis trutta*), kingfish (*Seriola lalandi*), mullet (*Mugil cephalus*), school shark (*Galeorhinus australis*) and snapper (*Pagrus auratus*).

Upper harbour association (Nucula hartvigiana-Austrovenus stutchburyi-Paphies australis)

This association occurs in the subtidal channels in the upper portions of the four major arms of Parengarenga Harbour (Fig. 3). It is not subtidally-limited and extends into the low tidal flats throughout a large portion of the harbour. Major elements, like cockle and pipi, also extend in patches up into mid-tidal areas.

This association is characterised by common, small nutshells *Nucula hartvigiana* (up to 500 per 10 l, stn. 42), and widespread, somewhat patchy, cockle *Austrovenus stutchburyi* (up to 21 per 10 l, stn. 43) and pipi *Paphies australis* (up to 640 per 10 l, stn. 44). Although cockle and pipi are more characteristic of intertidal situations, they also live subtidally here at recorded depths of up to 3 m and 4.5 m respectively. The wedge shell *Macomona liliana* occurs intertidally with these species but was not recorded living subtidally in this study.

Frequently occurring gastropods in this subtidal association are the scavenging whelks *Cominella adspersa* and *C. glandiformis, Neoguraleus lyallensis* and the horn shell *Zeacumantus lutulentus.* Seven species of crab (especially *Halicarcinus varius* and *H. whitei*) and one shrimp (*Pontophilus australis*) also live subtidally in this association.

Common among the smaller crustaceans are the cumacean *Cyclaspis thomsoni* and various amphipods (particularly *Proharpinia* sp., *Parawaldeckia thomsoni, Waipirophoxus australis, Paradexamine pacifica* and *Torridoharpinia hurleyi*), but isopods are rare.

Numerous polychaetes (29 species) are recorded in this association, with the most common, in order of decreasing abundance: undetermined nereids, cirratulids, maldanids, capatellids, *Orbinia papillosa, Aedicera* sp., *Scolecolepides benhami, Euchone* sp. and *Prionospio* sp. Also present in this association are the small sand-burrowing holothurian *Taeniogyrus* sp. and the hemichordate *Balanaglossus australiensis.*

Zonation along the subtidal channels

The subtidal biotic distribution shows a zonation from the harbour mouth towards the head of each arm (Fig. 4). Common taxa that are largely restricted to the more saline seaward regions include the molluscs *Tawera spissa, Pleuromeris zelandica, Myadora striata, Myochama tasmanica* and *Gari stangeri,* the polychaetes *Owenia fusiformis, Axiothella quadrimaculata, Armandia maculata* and *Aglaophamus macroura,* and the amphipods *Trichophoxus chelatus* and the phoxocephalids. The molluscs *Felaniella zelandica, Dosinia subrosea* and *Cominella quoyana quoyana,* and the polychaetes *Euchone* sp. and nereids, occur near the harbour mouth but extend further upstream than the former group.

Common taxa that predominantly occur in the more brackish landward end of the arms include the molluscs *Nucula hartvigiana, Austrovenus stutchburyi, Paphies australis, Cominella adspersa* and *C. glandiformis,* and the cumacean *Cyclaspis thomsoni.* The amphipods *Waipirophoxus australis, Proharpinia* sp. and *Paraweldeckia thomsoni,* and the crabs *Liocarcinus corrugatus* and hermit *Paguristes pilosus,* occur throughout most of the channel lengths.

Differences between the subtidal fauna of the arms

The bivalves *Gari stangeri* and *Pleuromeris zelandica* are largely confined to the lower reaches of Parenga and Waiheuheu Arms. The nutshell *Nucula nitidula* is limited to the lower Waiheuheu and Pohutu Arms, whereas the bivalve *Talabrica bellula* occurs only in three stations in the lower Waiheuheu Arm. In contrast to these bivalves, two species of olive shells *Amalda australis* and *A. novaezelandiae,* occur in every arm except the Waiheuheu.

Subtidal pipi were encountered only in the sandier Te Kao and Parenga Arms, being most abundant in the latter. Cockle and the nutshell, *Nucula hartvigiana,* occur subtidally in every arm but both were most abundant, like pipi, in Parenga Arm (Fig. 4).

SUBTIDAL HARD SUBSTRATES

Subtidal reefs have a highly restricted distribution in Parengarenga Harbour, confined to sites of strong current flow on channel margins, and extending from the intertidal zone to c. 2-10 m depth. A subtidal reef of well-indurated Miocene conglomerate is present at Ngatehe Point, and subtidal reefs of much softer Pleistocene sandstone are present further up harbour at Paua wharf, Tiawhakangari Point and Te Hapua. Wooden piles on wharfs at Paua and Te Hapua provide additional subtidal hard substrata at these locations.

Subtidal reefs and wharf piles in Parengarenga Harbour supported rich encrusting faunal assemblages dominated by sponges, hydroids and ascidians. These in turn provided shelter and food for many other invertebrates, including the topshells *Calliostoma pellucida, C. punctulata, C. tigris,* and nudibranchs *Aeolidia* sp., *Ceratosoma amoena, Chromodoris aureomarginata, Dendrodoris citrina, Phidiana milleri, Rostanga muscula* and *Trapania rudmani.* The reef at Ngatehe Point also had a luxuriant algal flora, with *Hormosira banksii* and coralline turf passing seaward into a dense band of kelps extending to c. 3 m depth, dominated by *Carpophyllum plumosum,* with less common *C. flexuosum, Ecklonia radiata* and *Sargassum sinclairii.* Below that, kelps were present only as scattered plants. By contrast, the subtidal reef at Akatere Point lacked kelp stands, although infrequent *Sargassum sinclairii* plants were present down to c. 5 m depth.

Reefs at Ngatehe Point and Paua wharf supported rich fish assemblages, with 20 species recorded (Appendix 2). The commonest fish associated with these reefs are common triplefin *Forsterygion lapillum,* leatherjacket *Parika scaber,* oblique-swimming triplefin *Obliquichthys maryannae,* parore *Girella tricuspidata,* spotted triplefin *Grahamina capito,* spotty *Notolabrus*

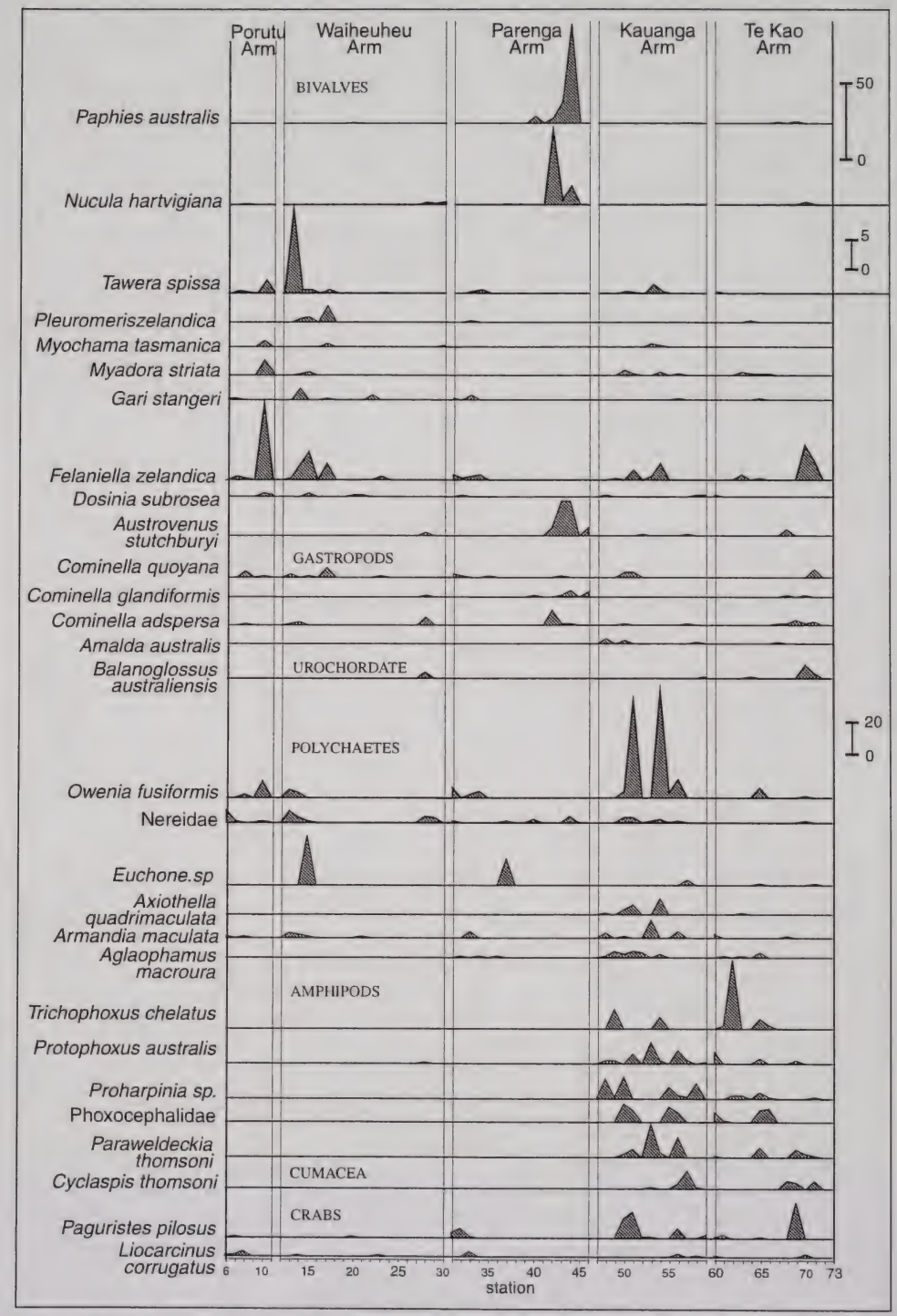

Fig. 4. Graphs showing number of individuals per 10 l of dredged sediment of the more common subtidal organisms with distance from the sea along the five arms of Parengarenga Harbour. In each arm the left hand side of the graph is nearest the harbour mouth and the right hand side is nearest the headwaters.

celidotus and sweep *Scorpis lineolatus*. As well as common coastal fish, two subtropical species were also recorded in December 1990. Two small juvenile mado *Atypichtyhs latus* (length c. 1.5 cm) were found sheltering amongst kelp at Ngatehe Point, and a few juvenile spotted black grouper *Epinephelus daemelii* (length c. 30 cm) were found in rock crevices at Ngatehe Point and Paua wharf.

ECOLOGICAL DISTRIBUTION PATTERNS OF INTERTIDAL BENTHIC ORGANISMS

SALT MARSH AND SALT MEADOW (Fig. 5)

Small areas of high tidal salt marsh and salt meadow vegetation occur at the heads of the many harbour arms and sometimes as a narrow strip between mangrove forest and the land. The largest areas of salt marsh are around the heads of the Parenga and Te Kao arms (Fig. 2). The salt marsh consists of various rushes and sedges, such as orange-tinted, jointed 'rush' *Leptocarpus similis*, sea rush *Juncus maritimus*, and *Scirpus medianus*. Sometimes occurring around the extreme high tidal mark above the taller salt marsh are salt meadow areas of low, prostrate plants dominated by the glasswort *Sarcocornia quinqueflora*, but frequently accompanied by other small plants, such as sea primrose *Samolus repens*, remuremu *Selliera radicans* and sea blite *Suaeda novae-zelandiae*.

The most obvious animals living in the salt marsh and meadow are the burrowing mud crab *Helice crassa*, and the mud snail *Amphibola crenata*. Also recorded living in the sediment are the isopod *Eurylana cookii* and the amphipod *Hyale grenfelli*. Sometimes present in large numbers at higher tidal levels in more brackish situations is the small, high-spired snail *Potamopyrgus estuarinus*. Occasionally found living high on the shore in the salt meadow, usually hiding beneath driftwood, stones or in clumps of rushes, are the small high tide ellobiid snails *Ophicardelus costellaris* and *Marinula filholi*, and the fast-running isopod *Ligia novaezelandiae*.

MANGROVE FOREST (Fig. 5)

Mangrove forest (*Avicennia marina*) covers large areas of Parengarenga Harbour above mid tide level. It is most extensive at the head and around the margins of all the arms (Fig. 2). The forest is generally 2-4 m high, with areas of lower, stunted forest often present above mean high tide level. The aerial roots, trunks and lower branches of mangroves are often encrusted with acorn barnacles *Austrominius modestus*, small black mussels *Xenostrobus pulex*, and clumps of Pacific oysters *Crassostrea gigas*. Cat's eyes *Turbo smaragdus*, the shell-less "slug" *Onchidella nigricans*, and *Nerita atramentosa* are sometimes found on the lower branches grazing algae. The sandy or muddy substrate beneath the mangroves is often pock-marked with the burrow openings of the mud crab *Helice crassa*, and inhabited by numerous mud snails *Amphibola crenata*, mudflat top shells *Diloma subrostrata*, and less commonly by the horn shell *Zeacumantus lutulentus*, and scavenging whelks *Cominella adspersa* and *C. glandiformis*.

At high tide, mangrove forests provide feeding areas for several fish species including kahawai *Arripis trutta*, grey mullet *Mugil cephalus*, parore *Girella tricuspidata*, and snapper *Pagrus auratus*.

ZOSTERA SEA GRASS FLATS (Fig. 5)

Extensive beds of seagrass, *Zostera*, cover over half the area of Parengarenga Harbour, mostly growing between low and mid tide levels. The only areas where seagrass is not well developed are around the harbour entrance and in the upper, muddier parts of Waiheuheu Arm (Fig. 2).

The sandy substrate beneath the seagrass is home to abundant cockles *Austrovenus stutchburyi*,

tiny nutshells *Nucula hartvigiana*, and five polychaete species, *Lumbrineris coccinea*, *Perinereis camiguinoides*, *Flabelligera bicolor* and unidentified species of *Terebellanice* and nereid. Also commonly present are the burrowing shrimps *Alpheus richardsoni*, *Heterosquilla tricarinata* and *Upogebia* sp., and the burrowing crab *Macrophthalmus hirtipes*.

A more diverse fauna, dominantly of gastropods, lives epifaunally among and on the grass blades. Most common are the bubble shells, *Bulla quoyii* and *Haminoea zelandiae*, the mudflat topshell *Diloma subrostrata*, and the scavenging whelks *Cominella adspersa* and *C. glandiformis*, but also present are 13 other snail species including the small herbivorous limpets *Notoacmea helmsi* f. *scapha* on the *Zostera* leaf blades, the opisthobranch *Bursatella leachii*, and the predatory snails *Charonia lampas*, *Conus lischkeanus*, *Cymatium e. exaratum*, *C. p. parthenopeum* and *Natica migratoria*. Other frequent members of the epifauna in tidal pools among the seagrass are the small fish *Favonigobius lateralis* and *Grahamina capito*, and the hermit crabs *Paguristes barbatus* and *Pagurus spinulimanus*.

SAND FLATS (Fig. 5)

Unvegetated, clean, white, quartz sand flats cover extensive intertidal areas in Parengarenga Harbour (Fig. 2). They are particularly prominent around the harbour entrance and the heads of the Parenga and Kauanga arms. Bare sand flats are infrequent in the upper parts of Waiheuheu and Te Kao arms.

A diverse fauna of 53 species (Appendix 2) was found living in or on the Parengarenga sand flats. The most abundant infaunal taxa are the bivalves *Austrovenus stutchburyi*, *Macomona liliana* and *Nucula hartvigiana*, the crabs *Helice crassa*, *Hemigrapsus crenulatus* and *Liocarcinus corrugatus*, the shrimps *Alpheus richardsoni* and *Palaemon affinis*, the isopod *Isocladus armatus*, and the polychaetes *Orchestia* sp. and unidentified nereids. Abundant epifaunal species are the cushion star *Patiriella regularis*, the gastropods *Cominella adspersa*, *C. glandiformis* and *Zeacumantus lutulentus*, and the chiton *Chiton glaucus* grazing algal films on shells.

The characteristic feeding excavations left by eaglerays *Myliobatis tenuicaudatus*, are obvious at low tide showing that the sand flats are important feeding areas when they are covered by the tide.

ROCKY HARBOUR SHORES (Fig. 6)

Low cliffs or banks of relatively soft, limonite-cemented Quaternary sandstone occur sporadically at mid and high tide levels around the shores of the Te Kao, Kauanga and Parenga Arms. Intertidal platforms and cliffs of harder Miocene mudstone, sandstone or conglomerate occur around the shores of Porotu and Waiheuheu Arms in the north.

Ninety-three species have been recorded alive from in, on and under intertidal rocks around the edge of the harbour (Appendix 2). The Quaternary sandstone of the southern shores is soft enough to be tunnelled by numerous crabs (*Helice crassa*) and isopods (*Isocladus armatus*) or occupied by the shrimps (*Palaemon affinis*), and nestling bivalve *Irus reflexus*. It is generally too soft to provide a suitable substrate for encrusting organisms like barnacles and oysters, or for grazing limpets or chitons. Common gastropods living on these soft mid-tidal rocks around Paua wharf are *Melagraphia aethiops*, *Lepsiella scobina* and *Dicathais orbita* and there are patches of Neptune's necklace *Hormosira banksii*. Since the normal food of *L. scobina* and *D. orbita* (e.g. barnacles, oysters and flea mussels) is absent here, it is a puzzle what they are eating. Under the wharf on shaded low to mid-tidal rocks is an established population of the trumpet shell *Ranella australasia australasia*. A few polychaete worms and purple rock crabs (*Leptograpsus variegatus*) find shelter beneath loose boulders of this soft sandstone in several places. Common small white gastropods (*Sinuginella pygmaea*) were living in sand in intertidal rock pools at Te

Fig. 5. Typical transect through the intertidal communities of Parengarenga Harbour with illustrations of the more common organisms of each habitat. Illustrations by MSM.

Hapua in the 1970s (Noel Gardner pers. comm.).

The harder Miocene rocks of the northern shores support a more diverse fauna, rich in gastropods and chitons. Particularly abundant are the grazing topshell *Melagraphia aethiops* and pulmonate limpet *Siphonaria australis,* and the encrusting Pacific oyster *Crassostrea gigas.* The hermit crabs *Paguristes pilosus* and *Pagurus novizelandiae* are abundant in shallow rock pools.

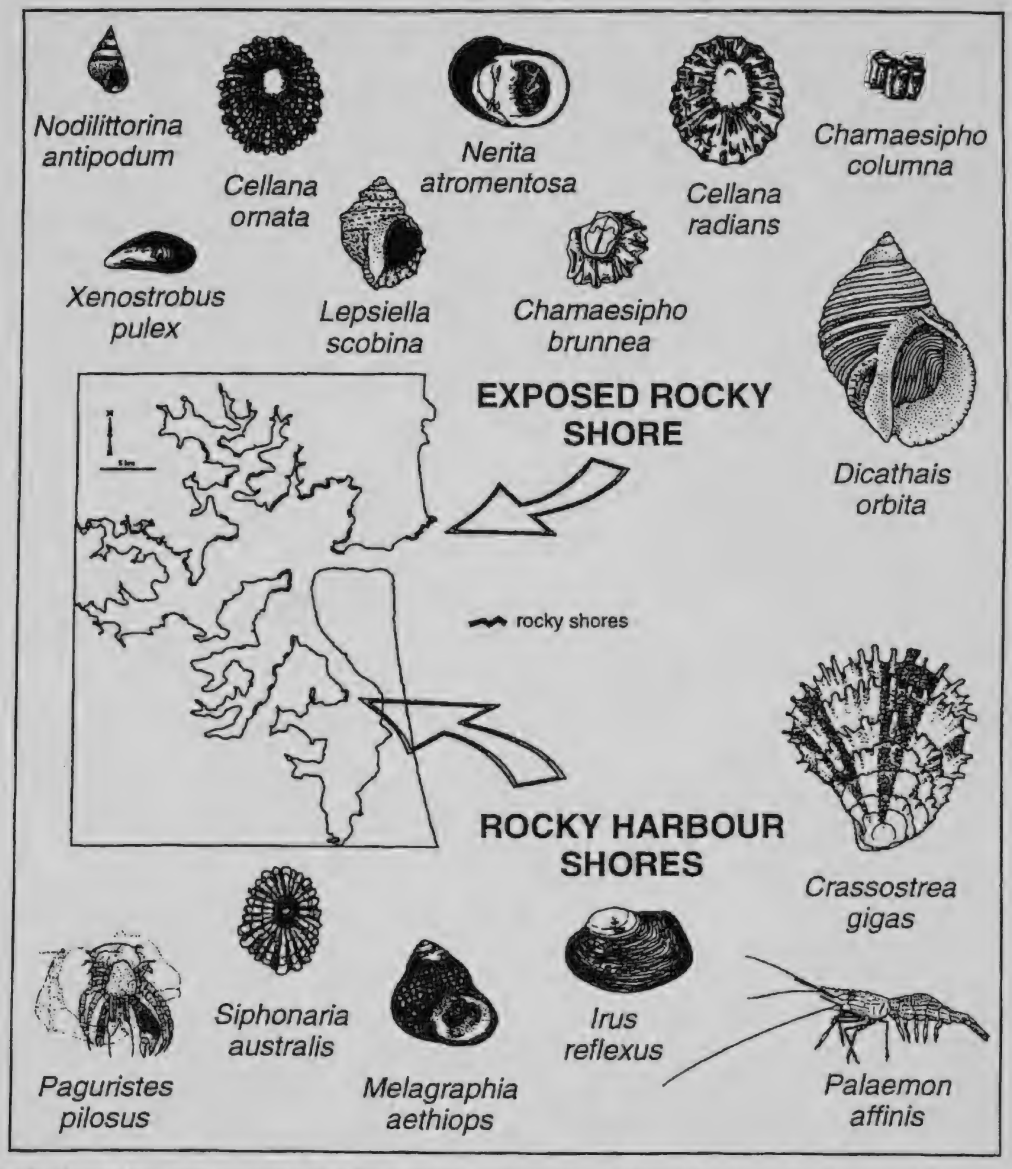

Fig. 6. Common organisms inhabiting rocky substrates in sheltered harbour and exposed open coast situations, Parengarenga. Illustrations by MSM, ABS and from Morton & Miller (1968).

EXPOSED BEACH

The exposed quartz sand beach on either side of the harbour entrance has few intertidal inhabitants apart from occasional tuatua *Paphies subtriangulata* and rarer low tidal to shallow subtidal *Dosinia subrosea,* toheroa *P. ventricosa*, and triangle shell *Spisula aequilateris.* Abundant specimens of the small wheel shell *Zethalia zelandica* live in the shallow subtidal sands on the north side of the harbour entrance. Washed up on the beach are the shells of many, mostly open coast molluscs (Appendix 2), including abundant shells of the the morning star shell

Tawera spissa and coiled internal shell of the pelagic *Spirula spirula*. Also washed up was a shell of the limpet *Cellana denticulata*. This species has a disjunct distribution centred on central New Zealand and the Three Kings Islands. It is common in prehistoric middens around northernmost Aupouri Peninsula but extremely rare alive in this region today.

EXPOSED ROCKY SHORES (Fig. 6)

Sixteen species were recorded living (Appendix 2) on the hard volcanic conglomerate forming the rocky shoreline on the north side of the outer entrance to Parengarenga Harbour (Fig. 1). The faunal abundance and composition differs considerably from that of the sheltered rocky shores inside the harbour. Here the dominant organisms at high tide are the grazing gastropods *Nerita atramentosa* and *Nodilittorina antipodum*, and at mid tide levels the encrusting barnacles *Chamaesipho brunnea* and *C. columna*, flea mussel *Xenostrobus pulex*, limpets *Cellana ornata* and *C. radians*, and predatory gastropods *Dicathais orbita* and *Lepsiella scobina*.

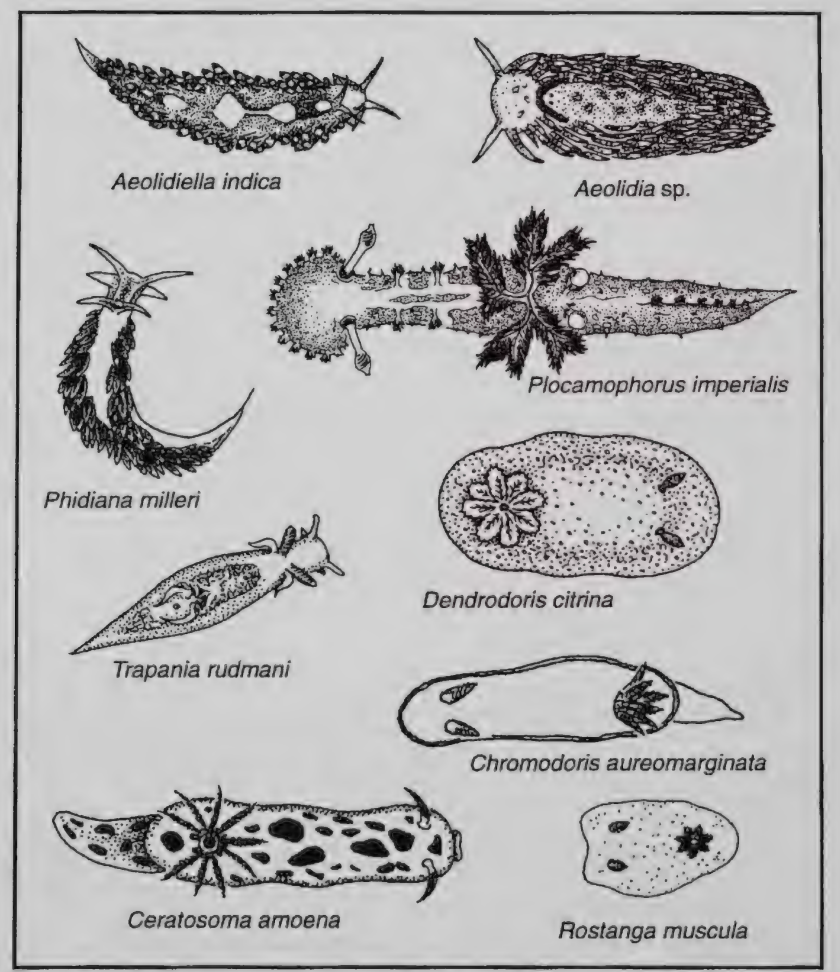

Fig. 7. Selection of nudibranchs from Parengarenga Harbour. All drawings by MSM.

NUDIBRANCHS (Fig. 7)

An unusually large number of colourful nudibranchs have been recorded from Parengarenga Harbour over the last few decades, many while snorkelling. Paua wharf area, on the edge of one of the main subtidal channels, is one of the prime sites. Here the white-bodied *Chromodoris aureomarginata* with a single gold line around the margin was seen in large numbers in November 1987 and October 1992 by MSM, approximately 10/m^2 crawling on the dark muddy sand. White spiral coils of spawn were laid nearby. Numerous specimens of the lemon-yellow *Dendrodoris citrina* are sometimes present on and under rocks near Paua wharf, and the clown nudibranch *Ceratosoma amoena* (white to yellowish body with orange blotches and purple rhinopores and gills) crawls exposed on rocks. *Aeolidiella indica* has been seen under low tidal rocks at Dog Island.

Nudibranchs periodically seen living on the Paua wharf piles are *Phidiana milleri, Aeolidia* sp., the small dorid *Trapania rudmani* (white body with two bright yellow stripes) and the small red *Rostanga muscula* on red sponges.

Nudibranchs seen in good numbers subtidally on sponges growing on soft sandstone cliffs at Te Hapua in October 1992 include *Ceratosoma amoena, Dendrodoris citrina* and *Chromodoris aureomarginata.*

Dysons Beach and Ngatehe Point on the north side of the harbour entrance, is also a favourable nudibranch habitat. Here *Dendrodoris citrina* lives on low tide rocks and the spectacular nudibranch *Plocamophorus imperialis* (pale peach to bright red with dark spots and two longitudinal cream stripes) crawls about at low tide among algae, sand and *Zostera* (Morley 1996). One specimen was seen in 1996 laying a spiral coil of orange spawn mass on a stone.

AMPHIPODA

Notwithstanding the lack of specifically targetted searches for amphipods, and therefore a considerable probability for under-reporting, there is evidence of a richness in phoxocephalid amphipods, which does not appear in other northern harbours. As a basis for comparison in diversity and numbers Cooper's (1969) records (three genera, nine species) from Wellington Harbour might be a near equivalent, and, as in Cooper's study, several taxa (3+) could not be identified. Parengarenga Harbour appears to be an ideal habitat for phoxocephalids with its extensive, warm, shallow-water channels and tidal flats with muddy fine sand substrates with good water circulation (beneficial to detrital feeders). Parengarenga Harbour must rank highly as a site for those wishing to explore the biogeographic radiation of this southern hemisphere Magellan-Austral amphipod family, which is strongly represented in Australian faunas (Barnard & Karaman 1991).

UNCOMMON WARM-WATER MOLLUSCA (Fig. 8)

GASTROPODA

***Aeolidia* sp.**, Aeolidiidae

Over 30 specimens were seen on Paua wharf piles in October 1992. Further study is required to identify *Aeolidia* specimens in New Zealand to species level (Richard Willan pers. comm.).

Aeolidiella indica Bergh, 1888, Aeolidiidae

One specimen of this rare nudibranch was found during our 1996 survey under a low tidal rock at Dog Island. Elsewhere in New Zealand it is recorded from the east coast of Northland

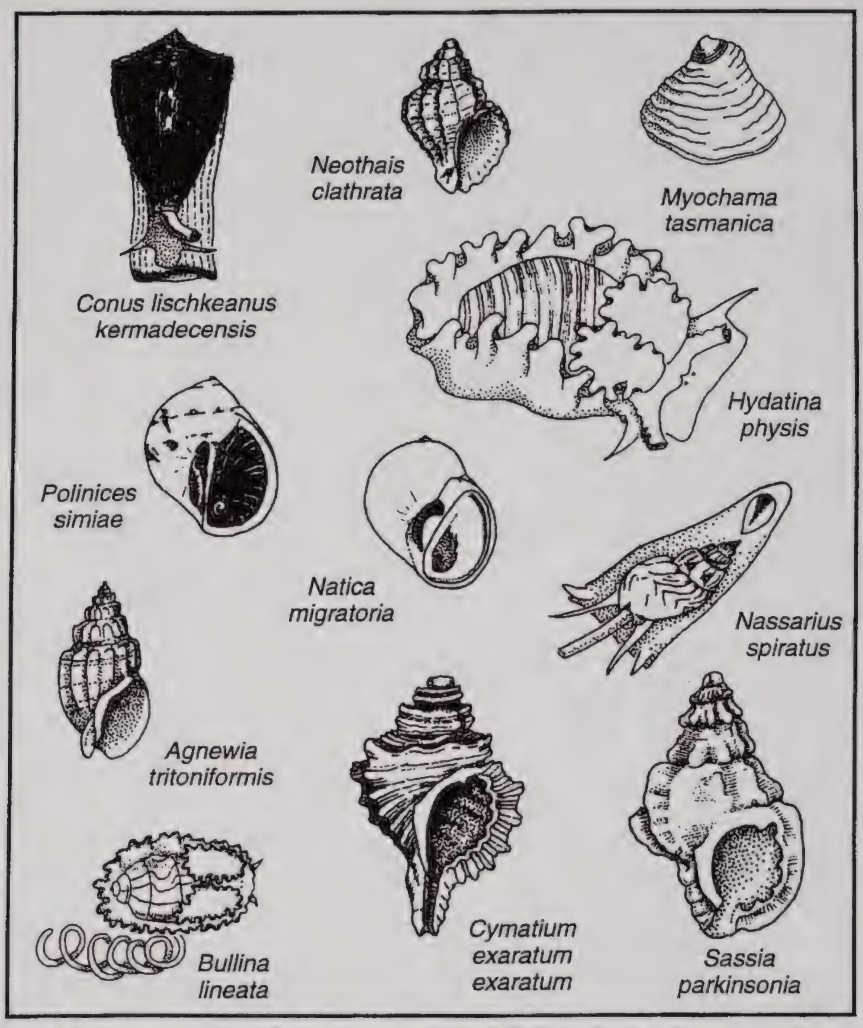

Fig. 8. Some of the uncommon molluscs recorded from Parengarenga Harbour. All drawings by MSM.

(Willan & Morton 1983). This species is widespread in the Pacific Ocean.

Agnewia tritoniformis (Blainville, 1833), Muricidae

Two dead specimens (AK104425) of this rare muricid were found subtidally in Parengarenga Harbour in 1996. Elsewhere in New Zealand it has been recorded from east coast of Northland, Great Barrier and Mayor Island (Powell 1979, MSM pers. obs.). It occurs on Norfolk Island.

Bullina lineata (Gray, 1825), Acteonidae

This delicate, red-lined bubble shell lives buried in the mud adjacent to Paua wharf. It is sometimes given away by its white spiral spawn masses on the surface. The animal has an iridescent blue border on a pale blue-grey mantle and is luminous at night (Richard Willan pers. comm.).

Calliostoma pellucidum (Valenciennes, 1846), Calliostomatidae

The handsomely marked northern form of this species (*spiratum*) was living at a depth of 1 m on rocks on or near Paua wharf in October 1993 (MSM pers. obs.).

Conus lischkeanus Wainkauff, 1875, Conidae

About 30 specimens of this cone have been found sporadically in the Parengarenga Harbour since 1972, living in the intertidal sand and *Zostera* flats. Specimens come out of the sand on the incoming tide, exposing a tomato-red siphon mottled with black. The foot is bright red at the anterior edge grading to peach posteriorly and mottled with black. The shell of live cones is covered with a tough, brown leathery epidermis. This cone is common in shallow water among algae on rocks around the Kermadec Islands, but is also widely distributed in the tropical West Pacific, including Norfolk and Lord Howe Islands. Kermadec specimens are about two-thirds the size of mature specimens found in the Parengarenga. Off New Zealand, it has also been found by divers in Whangaroa Harbour (Kevin Burch pers. comm.) and in deeper water as far south as the Bay of Plenty, near White Island (Marshall 1981).

Hydatina physis (Linnaeus, 1758), Hydatinidae

Several specimens of this striped bubble shell have been found in Parengarenga Harbour. MSM noted a pair mating in 2 m of water near Paua wharf in March 1986. The peachy pink mantle with a blue edge showed as a sharp contrast on the dark mud. It is rare in New Zealand waters.

Mesomarginella valei Powell, 1932, Marginellidae

A regionally endemic species, restricted to northernmost New Zealand (Powell 1979).

Nassarius spiratus (Adams, 1852), Buccinidae

Rare specimens of this whelk were noted by MSM leaving a trail in sand 1 m below low tide near Paua wharf in November 1987. The large body is white with fine opaque white speckles near the end of the foot. The animal is fast moving and has long tentacles and a proboscis nearly as long as the body whorl. In New Zealand it is recorded along the east coast of Northland from North Cape to the Mokohinau Islands (FJB pers. obs). It occurs on Lord Howe, Norfolk and Kermadec Islands.

Natica migratoria (Powell, 1927), Naticidae

Occasional specimens of this rare naticid have been seen alive in *Zostera* meadows and as sand trails off Paua in 1-3 m depths. It was first recorded and described from Te Hapua by Powell (1927).

Neothais clathrata (Adams, 1854), Muricidae

A live specimen of the small white whelk *Neothais clathrata* (AK138400) was found (by FT) in 1996 under a low tidal rock at Dog Island. This is the first recorded specimen of this Indo-west Pacific species in New Zealand (Willan 1998), although there is no evidence that it has established a breeding population here. The estimated larval life of this species is about a month or possibly slightly longer (Robertson 1980) and the nearest recorded populations are around Vanuatu (Willan 1998).

Polinices melanostomoides Quoy & Gaimard, 1833, Naticidae

In 1972, two dead specimens of this naticid were found in Parengarenga Harbour and one at

Rarawa (Powell 1974). These are the only records from New Zealand and clearly it has not established a breeding population in this country. The nearest recorded populations are in Queensland (Nancy Smith pers. comm.).

Polinices simiae Deshayes, 1838, Naticidae

Only dead specimens of this rare naticid were found on these surveys, but live specimens were found by Hunt Seelye at Paua in November 1972. This species is recorded from the Kermadec Islands (Brook 1998) and is widespread in the tropical Pacific.

Plocamophorus imperialis (Angas, 1864), Polyceridae

Four individuals of this spectacular nudibranch (AK104471) were observed crawling and spawning at and below low tide among algae, sand and *Zostera* at Dysons Beach and Ngatehe Point in 1996 (Morley 1996). This species was first seen in Parengarenga about 30 years ago (M.C. Miller pers. comm.) and the harbour appears to be its New Zealand stronghold. Its geographic range is throughout the tropical western Pacific Ocean (Willan & Coleman 1984).

Tutufa bufo Roding, 1798, Bursidae

This species distribution is predominantly tropical-subtropical. It is known from a few coastal sites in northeastern Northland (including Bay of Islands, Poor Knights) but is apparently transitory like *Conus*, *Hydatina*, *Polinices* spp. Previously recorded from Parengarenga by Powell (1979).

BIVALVIA

Myochama tasmanica (Tenison Woods, 1877), Myochamidae

This irregular bivalve was first recorded in New Zealand from Parengarenga Harbour (AK131434, Powell 1974). It lives in the subtidal channels attached by the right valve to the exterior of live shells and the interior of dead *Tawera spissa* or rarely *Paphies australis* (Powell 1974, Gardner 1976, this survey). In New Zealand, *M. tasmanica* is also known from Matai Bay (R. Willan in Gardner 1978), the Bay of Islands (Morley & Hayward 1999) and Three Kings Islands (FJB pers. obs.).

DISCUSSION

DIVERSITY

In this study we record 452 species, including 266 molluscs, 33 crabs and shrimps, 22 amphipods, 16 isopods, 50 polychaetes and eight echinoderms. The number of mollusc species at Parengarenga is less than half the 551 recorded from the larger and more diverse habitats of the Bay of Islands (Morley & Hayward 1999), 130 km south of Parengarenga, and considerably more than the 179 species recorded from the similar, but considerably larger area of the middle and upper Waitemata Harbour, Auckland (Hayward *et al.* 1999). However the Parengarenga biota is less rich than the Waitemata (number of species in brackets) in its diversity of crabs and shrimps (43), amphipods (57), isopods (30), polychaetes (106) and echinoderms (16). These diversity differences probably relate to many factors, such as greater nutrient concentrations, greater mud, greater turbidity and greater diversity of soft and hard substrate habitats in the Waitemata compared to the Parengarenga Harbour.

Parengarenga's low diversity in many phyla probably reflects the lack of diverse rocky shore

habitats around the harbour. For example there are very few boulders or cobbles to provide shade and shelter for a wide range of animals like the black 'slug' *Scutus breviculus,* the golden oyster *Anomia trigonopsis,* the gastropods *Amphithalamus* spp. and *Herpetopoma* spp., the seastars *Coscinasterias calamaria* and *Allostichaster polyplax,* the tunicates *Asterocarpa coerulea, Cnemidocarpa bicornuata* and *Pyura* spp., the sea anemones *Isactinia olivacea, Diadumene neozelanica,* and *Paractis ferox,* and intertidal sponges like *Aaptos aaptos* and *Tethya aurantium.* Some other unexpected absences from Parengarenga Harbour include the common harbour channel-dwelling bivalves *Corbula zelandica* and *Dosina zelandica,* and the heart urchin *Echinocardium cordatum.*

Despite Parengarenga's low diversity, we record 50 molluscan species that have not been found in the diverse Bay of Islands fauna (Morley & Hayward 1999). A probable explanation for many of these additonal records is the presence of extensive, shallow, warm-water *Zostera* and quartz sand flats in Parengarenga and the proximity of the harbour entrance to eddies of the warm East Auckland Current—a situation not repeated further south. These conditions may help facilitate the introduction and establishment of species with long larval phases from subtropical shores outside New Zealand.

Parengarenga Harbour is the type locality for at least three marine species—the naticid snail *Natica migratoria,* the gastropod *Chelidonura aureopunctula* (now a junior synonym of *Philinopsis taronga*) and bivalve *Lasaea parengaensis.*

PARENGARENGA'S QUARTZ SAND AND *ZOSTERA* FLATS

The vast intertidal quartz sand and *Zostera* flats around Paua and Te Hapua are an unusual habitat for New Zealand. The soft, knee-deep sand is stabilised by the *Zostera* and never dries out between tides. It is the permanent or periodic home to sparse specimens of several uncommon gastropods seldom seen intertidally elsewhere in New Zealand.

These gastropods include large carnivorous species, such as the trumpet shell *Charonia lampas* which preys on the cushion seastar *Patiriella regularis,* the ranellids *Cymatium e. exaratum, Cymatium p. parthenopeum, Sassia parkinsonia* and *Ranella a. australasia* which feed on molluscs, and the trumpet shell *Cabestana spengleri* that feeds on ascidians. Some of the *Cymatium e. exaratum* specimens have an unusually long up-turned anterior canal, perhaps as a reponse to living in soft mud. Elsewhere in New Zealand, the usual habitat of these predators is the rocky shore at and below low tide.

Another unusual carnivore that lived and bred in this intertidal habitat, at least in the 1970s and 1980s, was *Conus lischkeanus.* We know of no live specimens being found in the 1990s.

Three relatively uncommon naticids, *Polinices simiae* (November 1972, Hunt Seelye pers. comm.), *Natica migratoria* and *Tanea zelandica,* have been found in the surface sand and *Zostera* flats off Paua.

Four bubble shells inhabit this unusual habitat. Occasionally found partly buried in shallow depressions in the sand or muddy sand are the rare species *Bullina lineata* and *Hydatina physis.* The common brown bubble shell *Bulla quoyii* appears as a bump in sand among *Zostera,* and the common smaller white bubble *Haminoea zelandiae* crawls exposed in sandy pools.

INTRODUCED SPECIES

The only species recorded in Parengarenga Harbour that have been introduced to New Zealand as a result of human activities are the Pacific oyster, the cord grass *Spartina* and the Asian mussel *Musculista senhousia.* Of these, the Asian mussel is known only from two dead shells

(AK98910) collected in 1991 from Paua. This is its northernmost record in New Zealand and it has not yet spread to the West Coast. No specimens were observed in Parengarenga in our mid 1990s surveys. The Pacific oyster, *Crassostrea gigas*, is largely restricted to the few areas of hard substrate (e.g. abandoned oyster farms) and mangrove forest trunks and has not yet invaded the extensive intertidal flats and subtidal channels as it has done in some other northern harbours (Hayward & Hollis 1993, Hayward *et al.* 1999). Perhaps the most threatening of the exotic species is the introduced cord grass that was mapped in six patches up the Waiheuheu and Parenga Arms and appeared to be spreading. Harbours on the east coast of Northland and Auckland have been invaded by several other introduced species in the last few decades (e.g. Hayward 1997). These include two exotic bivalves that have the potential to thrive in Parengarenga, the thin-shelled *Theora lubrica* and *Limaria orientalis,* but neither was recorded in this study.

CHANGES SINCE 1970s

Fifteen of the 72 mollusc species dredged from the main Parengarenga Harbour channel in the 1970s (Gardner 1978) were not found in the 1990s (Appendix 2). Most notable were the large clumps of the vermetid *Novastoa lamellosa*. Other species in the Auckland War Memorial Museum collections collected by Dr Powell at Te Hapua, Parengarenga, from shore washings in October 1971, but not found in this study, are the pyramidellid *Odostomia haurakiensis,* rissoid *Rissoina chathamensis* and small bivalve *Mysella larochei*. Data on the state of the harbour's biota before the 1990s is insufficient to document any major natural or human-induced changes that may have occurred. Taxa recorded as present in the 1970s but not found in our 1990s survey are largely small, dead shells that are probably mostly still present but in low numbers.

Acknowledgements. We thank Glenys Stace, Michael Eagle and Annette Pullin for field assistance. Norman and Noel Gardner kindly provided information about their visits to Parengarenga in the 1970s. Hunt Seelye, Nancy Smith, Andrew Spurgeon and the late Damaris Hole provided additional species records and Richard Willan gave information on *Aeolidia* sp. and provided his observations on *Plocamophorus imperialis.*

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APPENDIX 1. Parengarenga Harbour sample station data with Auckland War Memorial Museum Marine Department sample locality numbers. HT = high tide, LT = low tide, MT = mid tide.

Stn.	Mus. Loc. No.	Latitude S	Longitude E	Depth (m)	Substrate type
Dredge stations					
1	L1716	34 31.5	172 58.7	5.0	fine-medium sand
2	L1715	34 31.35	172 58.3	0.2	fine sand
3	L1714	34 31.5	172 58.1	25.0	fine sand
4	L17015	34 31.65	172 57.61	6.0	fine sand
5	L17016	34 31.47	172 57.37	2.5	fine sand
6	L1717	34 31.32	172 57.8	10.0	shelly fine-medium sand
7	L1709	34 31.1	172 57.97	2.5	muddy pebbly medium sand
8	L1710	34 31.0	172 58.2	2.5	muddy fine sand
9	L1712	34 30.84	172 57.97	LT	muddy fine sand
10	L1711	34 30.83	172 58.2	2.5	slightly shelly medium sand
11	L1713	34 30.7	172 58.1	3.0	fine sand
12	L1729	34 31.3	172 57.5	7.5	fine-medium sand
13	L1705	34 30.9	172 57.2	3.6	shelly medium sand
14	L1707	34 30.7	172 57.0	5.0	muddy fine sand
15	L1704	34 30.6	172 56.8	6.0	muddy fine sand
16	L1708	34 30.4	172 56.9	LT	muddy fine sand, *Zostera*
17	L1706	34 30.6	172 56.6	3.2	muddy fine sand
18	L1723	34 30.7	172 56.5	LT	fine sand, *Zostera*
19	L1724	34 30.8	172 56.5	LT	fine sand, *Zostera*
20	L1701	34 30.6	172 56.3	3.0	shelly fine sand
21	L1702	34 30.6	172 56.0	2.5	shelly fine sand
22	L1703	34 30.6	172 55.8	2.1	muddy fine sand
23	L1722	34 30.6	172 55.2	6.5	medium sand
24	L1721	34 30.2	172 55.1	2.0	medium sand
25	L1720	34 29.8	172 55.6	5.0	fine sand
26	L1718	34 29.5	172 56.0	0.5	fine sandy mud
27	L1719	34 29.5	172 55.5	2.5	fine sand
28	L17014	34 29.26	172 54.76	0.5	shelly clean fine sand
29	L17013	34 28.90	172 55.04	0.0	muddy fine sand
30	L17012	34 28.79	172 54.4	0.1	shelly muddy sand
31	L1728	34 31.3	172 57.1	4.0	fine sand
32	L1727	34 31.2	172 56.7	7.0	fine-medium sand
33	L1726	34 31.2	172 56.3	6.0	shelly fine-medium sand
34	L1725	34 31.0	172 56.0	7.0	fine sand
35	L1737	34 31.2	172 55.5	6.0	fine sand
36	L1730	34 31.2	172 55.1	3.0	fine sand
37	L1731	34 31.4	172 55.0	2.5	muddy fine sand
38	L1732	34 32.0	172 55.0	1.0	muddy fine sand
39	L1733	34 32.5	172 54.95	4.0	shelly fine sand
40	L1734	34 32.4	172 54.3	2.8	fine sand
41	L17024	34 32.67	172 53.54	LT	shelly fine sand, *Zostera*
42	L1735	34 31.6	172 54.0	3.0	muddy fine sand
43	L1736	34 31.2	172 53.2	1.0	muddy fine sand
44	L17022	34 31.29	172 52.71	0.5	muddy medium sand

Stn.	Mus. Loc. No.	Latitude S	Longitude E	Depth (m)	Substrate type
45	L17023	34 31.06	172 52.62	LT	muddy fine sand
46	L17021	34 31.18	172 52.17	0.5	muddy medium sand
47	L17020	34 30.84	172 51.86	1.0	muddy very coarse sand
48	L17017	34 31.72	172 57.30	3.0	fine sand
49	L17018	34 31.97	172 57.17	2.5	shelly fine sand
50	L17001	34 32.05	172 57.07	2.5	fine sand
51	L17002	34 32.16	172 56.99	3.0	shelly fine sand
52	L17003	34 32.30	172 56.77	8.0	fine sand
53	L17004	34 32.25	172 56.65	10.0	gravelly shelly sand
54	L17005	34 32.32	172 56.45	6.0	slightly shelly fine sand
55	L17036	34 32.74	172 56.5	2.5	fine sand
56	L17035	34 33.58	172 56.70	4.5	slightly shelly fine sand
57	L17032	34 33.69	172 56.34	1.5	fine sand
58	L17034	34 34.06	172 56.40	2.5	slightly shelly fine sand
59	L17033	34 34.54	172 56.07	3.0	very shelly fine sand
60	L17019	34 32.33	172 57.12	7.0	shelly fine sand
61	L17031	34 32.71	172 57.18	7.0	shelly fine sand
62	L17030	34 33.04	172 57.46	5.0	fine sand
63	L17029	34 33.42	172 57.71	4.5	fine sand
64	L17028	34 33.87	172 58.3	5.0	slightly shelly fine sand
65	L17027	34 34.21	172 58.45	3.0	shelly fine sand
66	L17026	34 34.80	172 58.47	3.0	shelly fine sand
67	L17007	34 34.87	172 58.18	1.5	fine sand
68	L17006	34 34.77	172 57.91	1.0	fine sand
69	L17008	34 35.27	172 58.8	4.5	shelly fine sand
70	L17025	34 35.6	172 58.63	4.0	shelly fine sand
71	L17009	34 35.9	172 58.99	2.0	fine sand
72	L17010	34 36.1	172 58.78	LT	fine sand, *Zostera*
73	L17011	34 36.19	172 58.51	LT	fine sand, *Zostera*
Intertidal, snorkel and SCUBA stations					
	L16798	34 34.4	172 58.4	LT	sand
	L1691	34 30.5	172 58.4	LT	sand
	L17100	34 32.2	172 56.7	LT	sand
	L17106	34 28.79	172 54.4	HT	mangroves
	L17108	34 31.2	172 57.8	LT	sand, shell, rock
	L17117	34 31	173 00	HT-LT	rock
	L17121	34 30.4	172 57.3	HT	shell, sand
	L2744	34 30.8	172 58.0	LT	sandstone reef
	L13485	34 30.7	172 58	LT	*Zostera*
	L1797, 1799	34 31.1	172 55	1-2	mud
	L1798, 1801	34 32.1	172 56.7	LT	sand
	L1802-6	34 30.5	172 56.1	LT	mud, sand, rock, *Zostera*
	L1845	34 31.1	172 57.9	MT	rock pool
	L1847	34 31.1	172 58.2	LT	mud, sand
	L1915	34 31.4	172 57.9	LT	sand burrows
	L1916, 2600	34 31.2	172 58.1	LT	mud pools
	L2025	34 31.3	172 57.9	LT	seaweed
	L2612	34 31.2	172 54.8	MT	sand

Stn.	Mus. Loc. No.	Latitude S	Longitude E	Depth (m)	Substrate type
	L2613	34 32.5	172 55.2	LT	muddy gravel
	L2614	34 29.8	172 55.7	LT	mud
	L2615	34 30.6	172 58.5	LT	mud, sand
	L2782	34 32.0	172 56.5	1-2	soft sandstone

APPENDIX 2. List of species of macrofauna recorded from Parengarenga Harbour and their habitat distribution. D = dead; L = live; LL = abundant live. * = previously recorded (Gardner 1978, Powell 1974) or collected from Parengarenga but not found in our surveys. Molluscan names follow Spencer & Willan (1996), except for *Atrina zelandica, Charonia lampas, Ostrea lutaria, Scutus breviculus* and *Micrelenchus huttonii* (Marshall 1995, 1998a, b).

Habitats:

Ch = subtidal channel (183 spp.)
ZS = *Zostera* sea grass (43 spp.)
SF = intertidal sand flats (89 spp.)
HR = intertidal harbour rocks (116 spp.)
MF = mangrove forest (13 spp.)
SM = salt marsh and salt meadow (7 spp.)
SR = subtidal harbour rocks and wharf piles (12 spp.)
XB = exposed beach at harbour entrance (49 spp.)
XR = exposed intertidal rocks (16 spp.)

	Ch	ZS	SF	HR	MF	SM	SR	XB	XR
POLYPLACOPHORA									
Acanthochitona mariae	L								
Acanthochitona violacea				L					
Acanthochitona zelandica	L								
Acanthochitona sp.	L								
Chiton glaucus		L	LL	L					
Cryptoconchus porosus				L					
Ischnochiton maorianus				L					
Leptochiton inquinatus	L								
Plaxiphora obtecta									L
Pseudotonicia cuneata	L								
Rhyssoplax aerea	L								
Rhyssoplax stangeri	L								
Sypharochiton pelliserpentis				L					L
GASTROPODA									
Adelphotectonica reevi								D	
Aeolidia sp.							L		
Aeolidiella indica				L					
Agnewia tritoniformis	D							D	
Alcithoe arabica			D					D	
Amalda australis			L						
Amalda depressa			L	D					
Amalda novaezelandiae	L		L						
Amphibola crenata					L	L			
Anabathron excelsus				D					
Anabathron hedleyi			D						
Anabathron rugulosus				L					
Antisolarium egenum	D								
Aplysia parvula		L							
Argobuccinum pustulosum tumidum								D	
Assiminea vulgaris				L					
Asteracmea suteri	D								
Austrofusus glans			D					D	
Austromitra rubiginosa	D								
*Besla vaga**	D								
Bouchetriphora pallida	D								
Buccinulum linea	L			L					
Buccinulum vittatum				L					

	Ch	ZS	SF	HR	MF	SM	SR	XB	XR
Bulla quoyii		LL							
Bullina lineata	L								
Bursatella leachii		L	L						
Cabestana spengleri				L					
Caecum digitulum	D								
Calliostoma osbornei							L		
Calliostoma pellucidum							L		
Calliostoma punctulatum	L			L			L		
Calliostoma selectum								D	
Calliostoma tigris	L			D			L		
Cantharidus purpureus				D					
Cantharidella tesselata				D					
Cellana denticulata								D	
Cellana ornata				L				D	LL
Cellana radians				L				D	LL
Cellana stellifera								D	
Ceratosoma amoena	L			L					
Charonia lampas	L	L		L					
Chemnitzia sp.	D		L						
Chromodoris aureomarginata				L					
Cirsotrema zelebori			D						
Coluzea spiralis			D						
Cominella adspersa	L	LL	LL		L				
Cominella glandiformis		L	L	L	L				
Cominella maculosa				L					
Cominella quoyana quoyana	L								
Cominella virgata brookesi				L					
Conus lischkeanus		L	D						
Cookia sulcata				L					
Crepidula costata			D					D	
Crepidula monoxyla				L				D	
Crepidula profunda	D			D					
Cylichna thetidis	L		L						
Cymatium exaratum exaratum		L							
Cymatium parthenopeum parthenopeum	L	L							
Dendrodoris citrina				L					
Dicathais orbita				L			L		LL
Diloma arida				L					
Diloma bicanaliculata bicanaliculata				L					
Diloma coracina									L
Diloma subrostrata		LL	L		LL				
Eatoniella albocolumella				L					
Eatoniella limbata	L								
Eatoniella notalabia				D					
Eatoniella olivacea			D	L					
Eatonina atomaria				D					
Eatonina micans				D					
Eatonina subflavescens			D	D					
Epitonium jukesianum	D		D						
Epitonium minora			D					D	

	Ch	ZS	SF	HR	MF	SM	SR	XB	XR
Epitonium tenellum			D						
Fictonoba carnosa carnosa			D				L		
Gumina dolichostoma	D								
Haliotis virginea				D				D	
Haminoea zelandiae		L							
Hydatina physis	L								
Janthina globosa			D						
Janthina janthina			D						
Lepsiella scobina				L					LL
Leuconopsis obsoleta				L					
*Limulatys reliquus**	D								
Linopyrga rugata rugata			D						
Lodderia waitemata				D					
Maoricolpus roseus				L				D	
Marinula filholi				L		L			
Melagraphia aethiops			L	LL					
Melanochlamys cylindrica	L								
Merelina lyalliana			D	D					
*Merelina superba**	D								
Mesomarginella vailei	L								
Micrelenchus huttonii	D								
Micrelenchus rufozonus	D								
Monophorus fascelina	D								
Nassarius spiratus	L	D	D						
Natica migratoria	D	L	D						
Neoguraleus lyallensis			D	L					
Neoguraleus murdochi				L					
Neothais clathrata			L						
Nerita atramentosa				L	L				LL
Nodilittorina cincta									L
Nodilittorina antipodum				L					LL
Notoacmea elongata			D	L					
Notoacmea helmsi f. *scapha*		L	D						
Notoacmea helmsi		L							
Notoacmea subtilis	D								
*Novastoa lamellosa**	D								
*Odostomia haurakiensis**			D						
Onchidella nigricans				L	L				
Ophicardelus costellaris						L			
Paratrophon quoyi				L					
Penion sulcatus								D	
Pervicacia tristis	L								
Phidiana milleri							L		
Philine angasi		L	L						
Philinopsis taronga			L						
Pisinna olivacea impressa			D						
Pisinna manawatawhia				D					
Pisinna rekohuana lactorubra			D						
Pisinna semiplicata				D					
Pisinna zosterophila			D	L					

	Ch	ZS	SF	HR	MF	SM	SR	XB	XR
Plocamophorus imperialis		L							
Poirieria zelandica								D	
Polinices melanostomoides*									
Polinices simiae		D	D						
Potamopyrgus estuarinus						L			
Potamopyrgus pupoides									
Proxiuber australe	D								
Ranella australasia australasia	L			L					
Retusa oruaensis	D		D						
Risellopsis varia			D						
Rissoella flemingi			D						
Rissoella rissoaformis				D					
*Rissoina achatina**	D								
Rissoina anguina	D		D						
*Rissoina chathamensis**	D		D						
Rostanga muscula							L		
Sagenotriphora ampulla	D								
Sassia parkinsonia			D					D	
*Seila chathamensis**	D								
Semicassis pyrum								D	
Serpulorbis zelandicus								D	
Sigapatella novaezelandiae	D		D	L					
Sinuginella pygmaea	L		L	L					
Siphonaria australis				LL					
Siphonaria propria				L					
Skenella spadix			D						
Stephanopoma rosea	D		D		L				
Struthiolaria papulosa	D		D						
*Struthiolaria vermis**	D								
Suterilla neozelanica			D						
Syrnola lurida	D								
Tanea zelandica	D	D	L						
Taron dubius				L					
Tonna cerevisina								D	
Trapania rudmani							L		
Trichosirius inornatus	L		D						
Trivia merces	D								
Trochus tiaratus	L								
Trochus viridus				L			L		
Tugali elegans								D	
Turbo smaragdus		L		L	L				L
Tutufa bufo			D						
Volvarinella cairoma			D						
Xymene ambiguus	D								
Xymene plebeius	D								
Xymene traversi				D					
*Zaclys sarissa**	D								
Zeacolpus pagoda pagoda	D		D					D	
Zeacumantus lutulentus		L	LL		L				
Zeacumantus subcarinatus			D	L					

	Ch	ZS	SF	HR	MF	SM	SR	XB	XR
Zegalerus tenuis	L								
Zemitrella sp.				D					
*Zeradina odhneri**	D								
Zeradina ovata	D								
Zethalia zelandica	D							DD	
BIVALVIA									
Arthritica bifurca	L								
Atrina zelandica			D					D	
Austrovenus stutchburyi	LL	LL	L						
Barbatia novaezelandiae								D	
Barnea similis								D	
Borniola reniformis	L		D						
Chlamys zelandiae				D					
Condylocuna concentrica			D						
Crassostrea gigas				LL	L				
Cyclomactra ovata	D		D						
Diplodonta striatula				L					
Divaricella huttoniana								D	
Divariscintilla maoria			L						
Dosinia subrosea	L							D	
Felaniella zelandica	LL	L	D						
Gaimardia finlayi			D						
Gari convexa	L							D	
Gari lineolata	L								
Gari stangeri	L		D					D	
Glycymeris modesta	D								
Hiatella arctica			L						
Irus reflexus			D	LL					
Kidderia aupouria								D	
Kidderia costata				L					
Lasaea hinemoa				D					
Lasaea parengaensis				L					
Leptomya retiaria retiaria			L						
Limatula maoria								D	
Macomona liliana			LL						
Mesopeplum convexum								D	
Modiolarca impacta				D					
Modiolus areolatus			D	D					
Musculista senhousia			D						
Myadora antipodum	D								
*Myadora boltoni**	D								
*Myadora novaezelandiae**	D								
Myadora striata	L								
Myllita stowei								D	
Myllitella vivens vivens			D						
Myochama tasmanica	L								
*Mysella larochei**			D						
*Mysella tellinula**	D								
Neolepton antipodum			L	L					
*Nucula certisinus**	D								

	Ch	ZS	SF	HR	MF	SM	SR	XB	XR
Nucula hartvigiana	LL	LL	LL		L				
Nucula nitidula	L								
Ostrea lutaria			L						
Paphies australis	L		L						
Paphies subtriangulata								L	
Paphies ventricosa								D	
Pecten novaezealandiae	L		D					D	
Perna canaliculus				D				D	L
Philobrya cf. *modiolus*				L					
Pholadidea suteri								D	
Pleuromeris zelandica	L								
Pseudoarcopagia disculus				D					
Ruditapes largillierti	L								
Saccella bellula	D								
Scalpomactra scalpellum	L								
*Scintillona zelandica**	D								
Septifer cf. *bilocularis*								D	
Solemya parkinsoni		L	L						
Soletellina nitida	L								
Soletellina siliquens		D							
Spisula aequilateris								DD	
Talabrica bellula		L							
Tawera spissa	LL							DD	
Trichomusculus barbatus				D					
Tucetona laticostata								D	
Varinucula gallinacea	L								
Venericardia purpurata	L								
Xenostrobus pulex				L	L			D	LL
Xenostrobus securis	D								
CEPHALOPODA									
Octopus sp.	L								
Spirula spirula			D					D	
REPTANTIA									
Australeremus n.sp.	L								
Callianassa sp.			L						
Cyclograpsus lavauxi				L					
Eurynolambrus australis				L					
Halicarcinus aotearoa	L								
Halicarcinus pubescens			L						
Halicarcinus varius			L						
Halicarcinus whitei	L								
Helice crassa			LL		LL	L			
Hemigrapsus crenulatus	L		LL						
Leptograpsus variegatus				L					
Liocarcinus corrugatus			LL	L					
Macrophthalmus hirtipes		L	L						
Notomithrax minor	L								
Notomithrax peronii	L								
Ozius truncatus		L							
Paguristes barbatus	L	L							

	Ch	ZS	SF	HR	MF	SM	SR	XB	XR
Paguristes pilosus	L			LL					
Pagurus novizelandiae	L			LL					
Pagurus spinulimanus	L	L	L						
Pagurus n.sp.	L								
Petalomera wilsoni	L								
Petrolisthes elongatus				L					
Pilumnopeus serratifrons			L						
Plagusia chabrus				L					
Upogebia sp.		L							
DECAPODA									
Alpheus richardsoni		LL	LL						
Heterosquilla brazieri			L						
Heterosquilla tricarinata		L							
Hippolyte bifidirostris				L					
Palaemon affinis			LL	LL					
Periclimenes yaldwyni			L						
Pontophilus australis	L								
CIRRIPEDIA									
Austrominius modestus			L	L	LL				
Chamaesipho brunnea									LL
Chamaesipho columna									LL
Epopella plicata								D	L
Notobalanus vestitus								D	
Notomegabalanus decorus	L							D	
Tetraclita purpurascens				L					
OSTRACODA									
Diasterope grisea	L								
Leuroleberis zelandica	L								
Schleroconcha arcuata	L								
LEPTOSTRACA	L								
MYSIDA	L								
TANAIDACEA				L					
CUMACEA									
Cyclaspis thomsoni	L								
Gynodiastylis milleri	L								
ISOPODA									
Batedotea elongatus				L					
Cleantis tubicola	L								
Dynamenella n.sp.				L					
Eurylana arcuata	L								
Eurylana cookii						L			
Eurylana sp.	L								
Exosphaeroma chilensis	L								
Iais californica			L						
Isocladus armatus			LL	LL					
Isocladus dulciculus			L						
Ligia novaezelandiae						L			
Notatolana albicaudata	L								
Notatolana "angula"	L								
Notatolana sp.	L		L						

	Ch	ZS	SF	HR	MF	SM	SR	XB	XR
Pseudoaega quarta	L								
Sphaeroma quoyanum			L						
AMPHIPODA									
Ampelisca chiltoni	L								
Ampelisca sp. A	L								
Corophium sextonae	L								
Gammaropsis typica	L			L					
Hyale grenfelli	L					L			
Lysianassidae	L								
Melita awa	L			L					
Melita inaequistylis	L								
Orchestia sp.			LL						
Paracalliope novizelandiae	L								
Paracentromedon manene	L								
Paradexamine pacifica	L								
Paraperioculodes sp.	L								
Parwaldeckia thomsoni	LL								
Parwaldeckia sp.	L								
Phoxocephalidae	LL								
Phoxocephalapsidae	LL								
Proharpinia sp. 1	LL								
Waipirophoxus australis	LL								
Tetradeion crassum	L								
Torridoharpinia hurleyi	L		L						
Trichophoxus chelatus	LL								
POLYCHAETA									
Aedicera sp.	L								
Aglaophamus macroura	LL								
Amphitrite rubra	L								
Armandia maculata	LL								
Axiothella quadrimaculata	LL								
Boccardia syrtis	L								
Capitellidae	L								
Cirratulidae	L								
?Cirriformia tentaculatus				L					
Euchone sp.	LL								
Eupholoe sp.	L								
Euratella sp.				L					
Flabelligera bicolor	L	L		L					
Galeolaria hystrix									
Glycera americana	L								
Glycera lamellipodia	L								
Glyceridae	L								
Hemipodus simplex	L								
Hyboscolex longiseta	L								
Hyboscolex pacificus	L								
Irmula sp.	L								
Lepidonotus polychromus	L								
Lumbrineridae	L								
Lumbrineris coccinea		L							

	Ch	ZS	SF	HR	MF	SM	SR	XB	XR
Magelona papillicornis	L								
Maldanidae	LL								
Marphysa depressa	L								
Nereidae	LL	L	LL	L					
Orbinia papillosa	LL			L					
Owenia fusiformis	LL								
Paraprionospio sp.	LL								
Pectinaria australis	L								
Perinereis camiguinoides		L							
Perinereis nuntia f. *brevicirrus*	L								
Platynereis australis	L								
Polybranchia sp.	L								
Polynoidae	L								
Prionospio sp.	L								
Rhamphobrachium sp.	L								
Sabellidae	L								
Salmacina australis				D					
Schistomeringos sp.	L								
Scolecolepides benhami	L								
Spionidae	L								
Spirobranchus cariniferus				L					
Spirorbis sp.				L					
?*Sthenolepis* sp.	L								
Terebella sp.				L					
Terebellanice sp.		L							
Terebellidae	L		L						
SIPUNCULIDA									
Siphunculus maoricus			L						
Themiste minor huttoni									
NEMERTEA	L					L			
PLATYHELMINTHES	L		L						
Stylochoplana sp.	L								
ASTEROIDEA									
Astropecten polyacanthus	L		L						
Patiriella regularis		L	LL	L					
ECHINOIDEA									
Evechinus chloroticus				L					
Fellaster zelandiae			D						
OPHIOROIDEA									
Amphiura roseus	L								
Astrotoma waiti				L					
Ophionereis fasciata				L					
HOLOTHURIA									
Taeniogyrus sp.	L	L							
CNIDARIA									
Actinia tenebrosa				L					
Actinothoe sp.	L								
Anthopleura aureoradiata			L						
Edwardsia tricolor	L								

	Ch	ZS	SF	HR	MF	SM	SR	XB	XR
UROCHORDATA									
Pyura sp.				L					
HEMICHORDATA									
Balanoglossus australiensis	LL								
PISCES									
Arripis trutta	L				L				
Atypichthys latus						L			
Cheilodactylus spectabilis						L			
Chironemus marmoratus							L		
Epigonichthys benhami	L								
Epigonichthys hectori	L								
Epinephelus daemelii							L		
Favonigobius lateralis		LL							
Forsterygion lapillum							L		
Forsterygion flavonigrum							L		
Galeorhinus australis	L								
Girella tricuspidata					L		L		
Grahamina capito		L		L			L		
Limichthys polyactis	L								
Mugil cephalus	L				L				
Muraenichthys australis	L								
Myliobatis tenuicaudatus							L		
Notoclinops segmentatus							L		
Notolabrus celidotus							L		
Obliquichthys maryannae							L		
Pagrus auratus	L				L				
Parablennius laticlavius							L		
Parika scaber							L		
Pempheris adspersus							L		
Ruanoho whero							L		
Scorpaena cardinalis							L		
Scorpaena papillosus							L		
Scorpis lineolatus							L		
Scorpis violaceus							L		
Seriola lalandi	L								
Trachylochismus melobesia	L								
Upeneichthys lineatus							L		

NEW FOSSIL CRINOIDS (ARTICULATA: COMATULIDA) FROM THE LATE OLIGOCENE OF WAITETE BAY, NORTHERN COROMANDEL PENINSULA, NEW ZEALAND

MICHAEL K. EAGLE

Abstract. A new family, two new genera and two new species of articulate crinoids are described from the late Oligocene Torehina Formation at Waitete Bay, Coromandel Peninsula, North Island, New Zealand. The two species of New Zealand Cenozoic tropiometrids lived with stalked crinoids in a shallow, innershelf marine environment no deeper than 30 m. This runs counter to suggestions from the Northern Hemisphere that stalked crinoids moved offshore to deeper water in the Triassic. Both extinct species belong to an extant superfamily today found in warm waters of the Pacific Ocean. The Waitete Bay taxa are so far the only recorded evidence of fossil comatulid communities in New Zealand.

KEYWORDS: Articulata; comatulid; Pseudoconometridae n. fam.; Conometridae; *Moanametra* n. gen.; *Pseudoconometra* n. gen.; Oligocene; Duntroonian; Chattian; Torehina Formation.

INTRODUCTION

While visiting Waitete Bay, northern Coromandel Peninsula, in the early 1970s, Geoff Gillard collected fossilised columnals of the sessile stemmed crinoid *Neilsenicrinus waiteteensis* Eagle, 1993 and other fossil echinoderm fragments, including a comatulid centrodorsal. These were collected from a sandy, flaggy limestone outcrop exposed in a new road-cutting c.15 m above Waitete Bay Beach, near the Waitete Bay settlement. The fossil locality is part of the Torehina Formation (Kear 1955) of late Oligocene age, near the Duntroonian (Chattian)-Waitakian boundary (Eagle & Hayward 1993, Eagle 1993). Subsequent field work during late November 1995 yielded further echinoderm material, including the centrodorsal of another comatulid. These fossil comatulids, the first to be described from New Zealand, are the subject of this paper. A summary and map of the regional and Waitete Bay coastal geology is given in Eagle & Hayward (1993). A localised geological map and stratigraphic column for the Oligocene Torehina Formation comatulid fossil locality is shown in Fig. 1. Eagle & Hayward (1993) provide a palaeontological and palaeoenviromental assessment of the macrofauna found at this fossil locality. All taxa appear *in situ.*

Specimens collected from site number S10/f10 with numbers prefixed "AK" are lodged in the marine invertebrates type collection of the Auckland War Memorial Museum. Crinoid classification and nomenclature follows those used by Clark (1931), Rasmussen (1961), Rasmussen & Sieverts-Doreck (1978), Breimer (1978), Ubaghs (1978), and Messing (1997). Since the *Treatise on Invertebrate Paleontology* (Rasmussen & Sieverts-Doreck 1978), comatulid higher-level classification has been modified by Simms (1988), Milsom *et al.* (1994) and Meyer (1997).

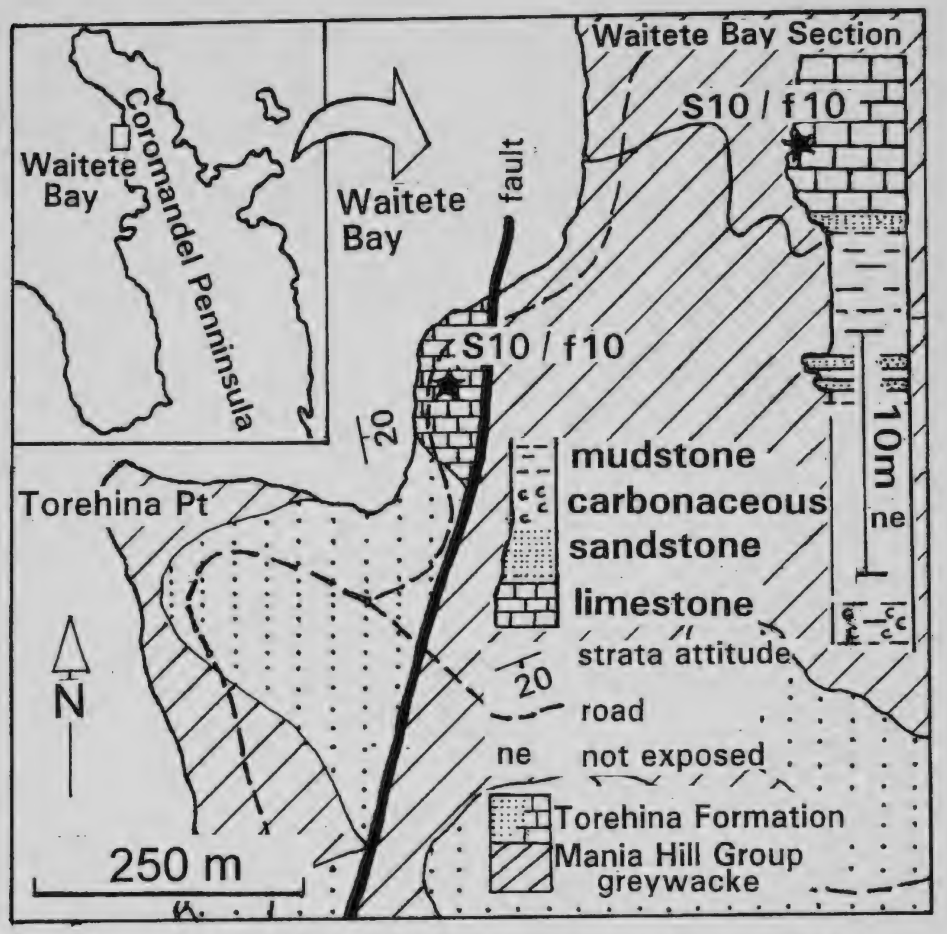


Fig. 1. Localised geological map and stratigraphic column in the immediate vicinity of the late Oligocene Torehina Formation comatulid fossil locality (after Eagle & Hayward 1993).

TYPE LOCALITY AND AGE

All the new species described in this paper have the following type locality and age. Fossil Record File number S10/f10; grid reference S10/289010 (NZMS 260 1:50 000), Torehina Formation (Kear 1955), Waitete Bay, Coromandel, New Zealand (Fig. 1). Duntroonian (Ld) (Chattian), late Oligocene (Eagle 1993, Eagle & Hayward 1993).

SYSTEMATICS

CLASS:	CRINOIDEA Millar, 1821
SUBCLASS:	ARTICULATA Zittel, 1879
ORDER:	COMATULIDA A.H. Clark, 1908
INFRAORDER:	COMATULIDIA Simms, 1988
SUPERFAMILY:	TROPIOMETRACEA A.H. Clark, 1908

Pseudoconometridae n. fam.

Stratigraphic range. Late Oligocene (Duntroonian-Chattian).

Diagnosis. Centrodorsal conical, ventral face circular with five radial pits, five indistinct basal furrows; dorsal with large cirrus-free area without dorsal star. Centrodorsal covered in 15 vertical columns of 7-10 cirrus sockets without ornament, with central, large, circular axial canal; sockets separated by smooth, radial, interradial ridges in rounded section.

REMARKS

Fossil genera resembling modern Tropiometracea in the form of centrodorsals, radials and arrangement of cirrus sockets, are included in this family. Clarke (1915) assigned the Tropiometridae to the Oligophreata, based on the relatively small size of the centrodorsal cavity, but Gislén (1924) and Rasmussen & Sieverts-Doreck (1978) consider the distinction neither natural nor sharp (Messing 1997).

Allocation of the Pseudoconometridae to the Tropiometracea is based on morphological similarity with families already taxonomically grouped within the superfamily. The pseudoconometrid centrodorsal is similar to that of the Conometridae Gislén, 1924, (in particular the genera *Conometra* Gislén, 1924 and *Amphorometra* Gislén, 1924), and similar to one species of *Jaekelometra* Gislén, 1924 of the Paracomatulidae = Paracomaulacea Hess, 1951. Although genera of the Pseudoconometridae, Conometridae, and sometimes Atelecrinidae Bather, 1899 possess tiered lateral circlets of cirrus sockets, only the Psuedoconometridae and Conometridae are without distinct ornament or with feeble articular tubercles. The Atelecrinidae, in particular *Jaekelometra*, has cirrus sockets with a more or less distinct fulcral ridge or articulating tubercles. The number and vertical arrangement of cirrus sockets in these families differ considerably. Conometridae have cirrus sockets arranged in 10 distinct, exceptionally 15 crowded, columns of 3-6 sockets, and the Atelecrinidae have cirrus sockets arranged in 10 vertical columns (15 in *Atelecrinus conifer*), each with 4-7 sockets commonly separated by interradial ridges (which may appear serrate due to projecting lateral margins of cirrus sockets), or space. The single example of Pseudoconometridae has cirrus sockets arranged in 15 columns of 7-10 sockets. Unknown in other families of the Tropiometracea, and unique to the Pseudoconometridae, are five radial pits on the centrodorsal ventral facet lacking a radial circlet. Also peculiar to Pseudoconometridae are semi-circular, concave cirrus sockets having large-diameter, circular axial canals at centre, and laterally adjacent articular tubercles. Conometrids and atelecrinids have sub-circular to circular concave cirrus sockets with small-diameter axial canals that are circular to ovoid. Pseudoconometridae, like the Conometridae, also possess a moderately large centrodorsal cavity with an overhanging peripheral edge, and a rugose cirrus-free dorsal area that is without a dorsal star.

Pseudoconometra n. gen.

Type species: *Pseudoconometra coromandelensis* Eagle.
Stratigraphic range: Duntroonian (Chattian).
Etymology: Named "pseudo" (false) for its similarity to the Conometridae.

Diagnosis. Centrodorsal high, conical with rounded cirrus-free dorsal area without dorsal star. Ventral face devoid of radial circlet, circular, with five radial pits, five indistinct basal ray furrows. Fifteen vertical columns each with 7-10 cirrus sockets possessing feeble articular tubercles. Cirrus sockets separated by radial, interradial ridges.

DESCRIPTION

Centrodorsal high, conical; ventral face roughly circular, with five large, oval radial pits 0.05 mm equidistant from peripheral edge of centrodorsal cavity. Coelomic impressions faint. Five indistinct, thick, basal ray furrows rounded proximally, terminate ovally at raised interradial points distally. Depressed subtriangular interradial areas. Large, deep, roughly subpentagonal centrodorsal cavity, 0.3 diameter of centrodorsal with overhanging edge. Large, rugose, cirrus-free dorsal area. Dorsal pole truncate-rounded, without dorsal star or impression. Steep sides of centrodorsal with 7-10 circular to ovoid, moderately deep, concave cirrus sockets. Fifteen vertical columns of closely touching cirrus sockets increase in size ventrally; laterally they are generally arranged symmetrically in opposition, separated at radial, interradial points by ridges. Cirrus sockets without articular ridge or marginal crenullae. Large round axial canal at centre. Radial circlet and cirri absent.

REMARKS

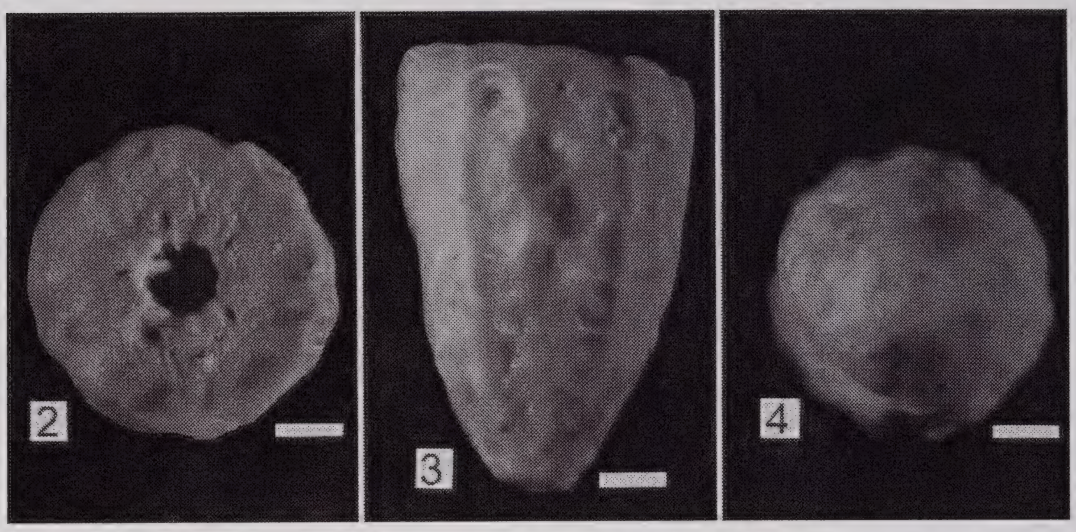
Pseudoconometra is morphologically most similar to *Conometra* (Eocene-Miocene; Europe) and *Amphorometra* (Cretaceous-Early Tertiary; Europe, Africa) of the Conometridae. Gislén (1924) distinguished the two genera by the presence or absence of a subradial cleft and whether or not basals are visible. Rasmussen (1961) regarded the arrangement of cirrus sockets as diagnostic, defining this as a character of the *Amphorometra*. *Conometra* has 15 vertical columns each with 4-5 cirrus sockets or 20 vertical columns with a similar number of cirrus sockets in each column; *Amphorometra* usually has only 10 vertical columns, each with 5-6 cirrus sockets. *Pseudoconometra*, *Conometra*, and *Amphorometra* all have cirrus sockets increasing in size toward the ventral face. Despite the radial circlet in *Pseudoconometra* being known only from faint coelomic impressions, depressed subtriangular interradial areas and indistinct basal furrows, the presence of five radial pits and arrangement of 15 vertical columns of 7-10 cirrus sockets (increasing in size upward toward the ventral face) allows confident separation from *Conometra* and *Amphorometra*. The Late Cretaceous genus *Jaekelometra* sometimes has a centrodorsal that is bluntly conical with a more or less concave ventral face, with shallow radial pits surrounding a medium sized cavity, and cirrus sockets that are also without marginal crenellae. However, *Jaekelometra* differs from *Psuedoconometra* in having a centrodorsal with fewer (3-5) cirrus sockets meeting interradially and arranged in 10 more or less distinct vertical columns. *Jaekelometra* sometimes shows a narrow, smooth lateral radial area in the upper part of the centrodorsal, which is not present in *Pseudoconometra*.

The moderately large, high-standing, conical centrodorsal with a smooth, evenly granulated, cirrus-free dorsal surface, large number and particular arrangement of cirrus sockets separated by smooth, rounded radial and interradial ridges, and a roughly circular ventral face with five radial pits surrounding a moderately large centrodorsal cavity, all serve to differentiate *Pseudoconometra* from other comatulid genera. Morphological similarities such as overall shape, cirri configuration and size, suggest that *Pseudoconometra* may have been derived from a Cretaceous conometrid such as *Amphorometra*.

Pseudoconometra coromandelensis n. sp. (Figs 2-5)

MATERIAL

Holotype. AK72847, centrodorsal cup without radial circlet or cirri. Collected by the author, November 1995 (*in situ*).



Figs 2-4. Holotype of *Pseudoconometra coromandelensis* AK72847. 2. Ventral face. 3. Lateral view. 4. Dorsal view. Scale line = 1 mm.

DESCRIPTION OF HOLOTYPE

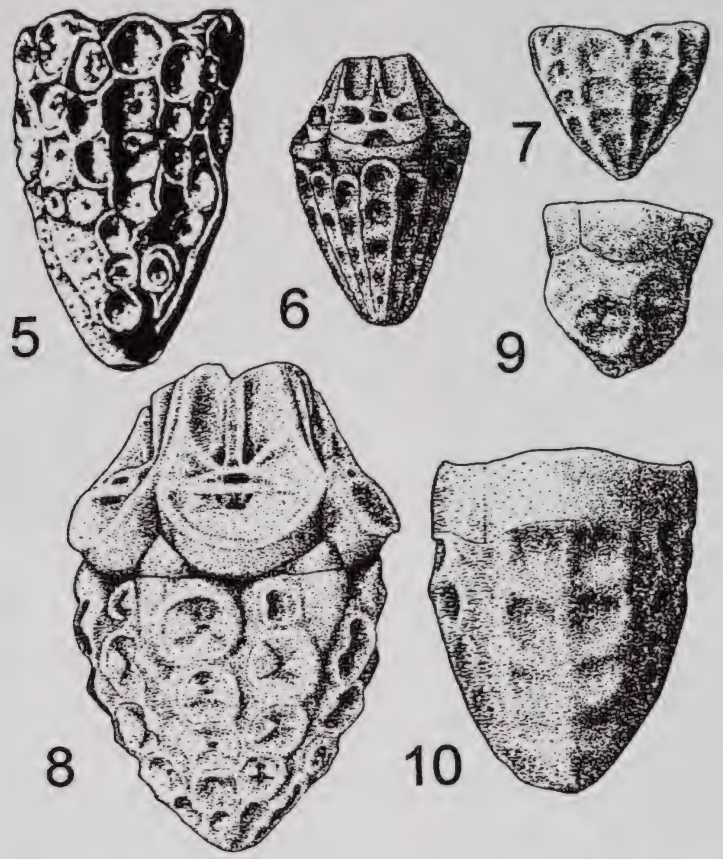
Centrodorsal high, conical; ventral facet roughly circular, irregular, rounded at edge, smooth, concave. Basal ray furrows five, indistinct, thick, with rounded ends, intersecting gently raised rim of centrodorsal cavity proximally, tapering towards raised interradial points distally. Five large, shallow, oval radial pits in surface between cavity and centrodorsal edge, 0.05 mm equidistant from cavity, located centrally in radial sections. Interradial areas raised, smooth, subtriangular. Centrodorsal cavity large, deep, roughly subpentagonal with overhanging edge, 0.3-0.4 diameter of centrodorsal. Large, smooth, cirrus-free dorsal area, dorsal pole truncate-rounded, without dorsal star or impression, granulose. Steep, inwardly sloping sides of centrodorsal covered in 15 crowded vertical columns of 7-10 closely touching, circular to subcircular, moderately deep, concave cirrus sockets, each with a central wide, deep axial pore. Axial canal at centre of two feeble articular tubercles laterally aligned. Cirrus socket margins without ornament; smooth slightly raised, rounded borders of similar height, size. Cirrus sockets increase in size ventrally, symmetrically arranged laterally in opposition. Cirrus sockets meet at radial, interradial points with no free space, separated by thick, smooth, rounded, continuous zig-zagging ridges of uniform height and size. Radial circlet, cirri unknown. Measurements (mm): centrodorsal diameter 4.6; centrodorsal height 6.7.

ETYMOLOGY

Named after the Coromandel Range and Peninsula.

REMARKS

The type species of *Conometra*, *C. alticeps* (Philippi, 1844) (Eocene, Italy; Fig. 6) is morphologically the most similar comatulid to *Pseudoconometra coromandelensis*. *C. alticeps* differs in having no radial pits, having 15 columns of 4-5 cirrus sockets (instead of the 15 columns of 7-10 cirrus sockets of *P. coromandelensis*), and in having straight radial and interradial



Figs 5-10. Illustrations (lateral views) of fossil centrodorsals most similar to *Pseudoconometra coromandelensis* (Fig. 5, x5). 6. *Conometra alticeps* (x10). 7. *Amphorometra conoideus* (x10). 8. *A. brydonei* (x10). 9. *Jaekelometra belgica* (x10). 10 *J. columnaris* (x10). [Fig. 6 from Phillipi (1844); Figs 7-10 from Rasmussen (1961).]

ridges that do not zig-zag. The type species of *Amphorometra*, *A. conoideus* (Goldfuss, 1840) (Late Cretaceous; Fig. 7), differs from *P. coromandelensis* by being about as high as wide, in having the centrodorsal devoid of radial pits, is covered in 10 columns each consisting of 3-5 cirrus sockets instead of the 15 columns of the 7-10 cirrus sockets of *P. coromandelensis*, and interradial rows may be separated by flat areas instead of rounded ridges as in *P. coromandelensis*. *Amphorometra brydonei* Gislén, 1924 (Fig. 8) (Late Cretaceous), another conometrid, is similar to *P. coromandelensis* but lacks radial pits, has 10 columns of 3-6 cirrus sockets, a pointed dorsal side, radial and interradial furrows between the rows of cirrus sockets, and is not as tall. The *Jaekelometra* type species, *J. belgica* (Jaekel, 1901) (Late Cretaceous; Fig. 9), is quite unlike *P. coromandelensis*, but, *J. columnaris* Gislén, 1924 (Fig. 10) has a high, conical shape with a rounded or slightly subpentagonal ventral outline. Shallow radial pits and indistinct basal furrows are also present in *columnaris* as in *P. coromandelensis,* but the centrodorsal with 10 vertical columns of 3-5 cirrus sockets symmetrically aligned laterally and meeting interradially, sometimes separated in the upper part of the centrodorsal by a wide, smooth, free radial area, is different

from the new species. The arrangement of 15 columns each with 7-10 deeply concave cirrus sockets (having large, circular axial canals) symmetrically opposing one another laterally, separated by zig-zagging, smooth, rounded radial, interradial ridges and a cirrus-free dorsal area without dorsal star or impression, differentiate *P. coromandelensis* from other comatulids.

FAMILY CONOMETRIDAE Gislén, 1924

Type genus. *Conometra* Gislén, 1924.
Stratigraphic range. Late Cretaceous-Miocene.

Diagnosis. Centrodorsal conical or truncated conical having rounded or flattened dorsal area without dorsal star. Centrodorsal cavity 0.2-0.3 of centrodorsal diameter or larger. Centrodorsal lateral with 3-6 cirrus sockets increasing in size upward in 10-20 columns. Radials usually with free dorsal surface. Articular face of radials generally high, with high, narrow ventral muscular fossae surrounding narrow radial cavity. Ventral muscular fossae may be lower, wider. Radial cavity funnel-shaped, markedly widened at ventral edge (Rasmussen & Sieverts-Doreck 1978).

REMARKS

Conometridae include fossil genera resembling modern Tropiometracea in the form of the centrodorsal and radials, and in arrangement of cirrus sockets. Other forms, including the genus *Jaekelometra* were classified within the Conometridae but have been transferred to the Atelecrinidae (Rasmussen & Sieverts Doreck 1978).

Moanametra n. gen.

Type species. *Moanametra torehinaensis* n. sp.
Stratigraphic range. Duntroonian (Chattian).

Diagnosis. Centrodorsal arched conical with cirrus-free dorsal area. Two to four cirrus sockets arranged in 15 vertical columns. Basals concealed. Radial circlet 1/4 as high as centrodorsal. Articular face low, wide.

DESCRIPTION

Centrodorsal arched conical with rounded, rugose, cirrus-free dorsal area without dorsal star or impression. Tiered, irregular lateral circlets of 2-4 cirrus sockets with indistinct articular ridge arranged in 15 vertical columns, increase in size orally. Basals concealed. Radial circlet 1/4 as high as centrodorsal. Radial articular face low, wide; reduced ventral muscular fossae smaller than moderately deep interarticular ligament fossae with semi-elliptical ligamental pit. Radial cavity funnel-shaped, with inwardly radiating furrows directed downward toward the centre, cavity widened at ventral edge.

ETYMOLOGY

Named by combining the Maori word "moana", meaning sea or ocean, and the comatulid suffix "metra".

REMARKS

The morphology of another conometrid, *Amphorometra*, and an atelecrinid, *Jaekelometra*, is similar to that of *Moanametra*. Although centrodorsal form varies in all three genera, the major diagnostic difference between the new genus and the two existing genera, is that *Moanametra*

have 2-4 cirrus sockets in 15 vertical columns covering the centrodorsal, *Amphorometra* has 3-5 cirrus sockets in 10 vertical rows, and *Jaekelometra* has 2-6 cirrus sockets in 10 vertical columns. Centrodorsal form, cirrus socket configuration, and radial circlet differences show *Moanametra* to be unlike any other comatulid.

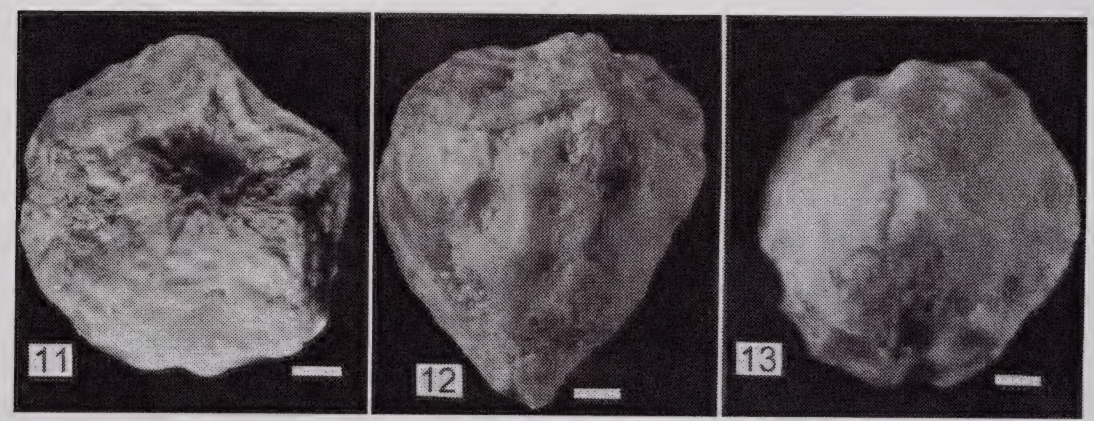
Moanametra torehinaensis n. sp. (Figs 11-14)

MATERIAL

Holotype. AK72848, centrodorsal with radial circlet, minus cirri. Collected by Geoff Gillard, 1973 (*in situ*).

DESCRIPTION OF HOLOTYPE

Centrodorsal arched, conical, with rounded, rugose, cirrus-free dorsal area. Centrodorsal with inwardly sloping sides covered with tiered, irregular, lateral circlets of 2-4 circular sockets decreasing in size dorsally, arranged in 15 vertical columns. Cirrus sockets small, moderately concave, with central narrow axial canal, indistinct articular ridge, and smooth margins without ornament. Interradial ridges of uniform height, smooth, rounded. Radial showing median zig-zag prolongation into uppermost uneven circle of cirrus sockets where they terminate. Basals concealed at interradial points. Radial circlet stellate in outline ventrally, laterally 1/4 as high as centrodorsal, with edges turned inside edge of centrodorsal periphery, and adoral grooves intersecting calyx radial cavity. Radial external free facet reduced; dorsal ligament fossae semi-elliptical, deep. External edge of dorsal ligament a high, narrow lip thickened at dorsal extremity; occasionally touching cirrus sockets; extending in reducing form to junction of radial septum. Articular face of radials low, wide. Synarthrial articulation of missing brachials established by straight, thick transverse ridge broken mid-way by a deep, semi-circular central axial canal aperture sited above deep, ovoid, ligamental pit. Transverse ridge junction reaches interradial septum half-way above centrodorsal. Dorsal ligament fossae low, about 1/10 theca height, larger than muscular fossae. Muscular fossae low, confined beneath interradial edge of articular face of radials, forming almost horizontal linear bands at ventral extremity, curved downwards along radial septum adjoining moderately wide midradial furrow; ventral edge slightly curved with



Figs 11-13. Holotype of *Moanametra torehinaensis* AK72848. 11. Ventral face. 12. Lateral view. 13. Dorsal view. Scale line = 1 mm.

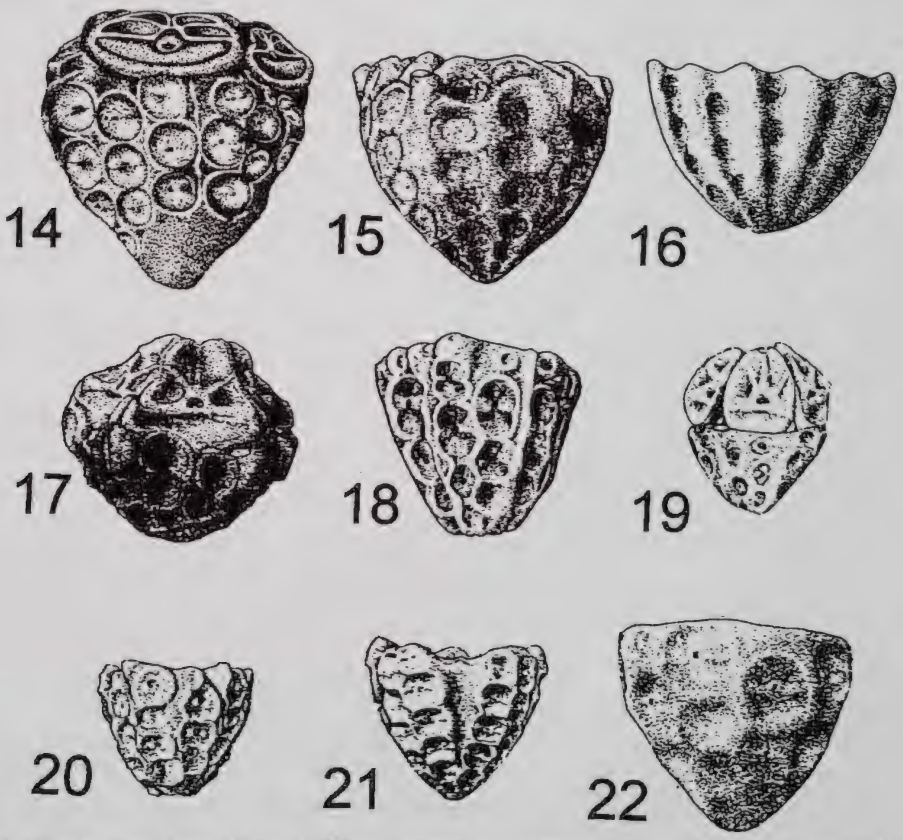
median notch. Radial rossette collapses deeply inward at centrodorsal cavity; five large radial furrows, 20 distinct but smaller interradial furrows inwardly sloping downward into theca radial cavity centre. Basals concealed. Theca radial cavity broadly circular, about $^1/_3$ diameter of centrodorsal. Radial cavity narrow. Measurements (mm): calyx diameter 8.2; theca height 8.9; centrodorsal height 6.2; external height of free radial face 0.3; radial facet length 2.4; radial facet width 3.9; inclination of radial facet 43 degrees.

ETYMOLOGY

Named after the Torehina Formation.

REMARKS

Another conometrid genus, *Amphorometra*, includes several species that are morphologically similar to *Moanametra torehinaensis*. The new species has 2-4 cirrus sockets in 15 vertical rows covering the centrodorsal, while *Amphorometra* species have 3-6 cirrus sockets in 10 vertical columns. Other characteristics (low radial facet, lack of defined interradial ridge) differentiate *Moanametra torehinaensis* from *Amphorometra*. Cretaceous species, including the type



Figs 14-22. Illustrations (lateral views) of fossil centrodorsals most similar to *Moanametra torehinaensis* (Fig. 14, x10). 15. *Amphorometra bruennichi* (x10). 16. *A bellilensis* (x5). 17. *A. semiglobularis* (x10). 18. *A. pyropa* (x10). 19. *A. rugiana* (x10). 20. *A. parva* (x10). 21. *Jaekelometra meijeri* (x5). 22. *J. concava* (x10). [Figs 15-22 from Rasmussen (1961).]

Amphorometra connoideus (Fig. 7), are similar to *Moanametra torehinaensis* but differ in form; their centrodorsals are of similar shape and size, but *Amphorometra* usually have straight, vertical interradial ridges or free space between columns of cirrus sockets. Compared to *M. torehinaensis* the centrodorsal of *A. connoideus* is subpentagonal instead of roughly circular, has a much larger centrodorsal cavity, possesses distally enlarging basal furrows, and has broader, ovate (rather than circular) cirrus sockets. The centrodorsal face of *A. bruennichi* (Rosenkrantz, 1944) (Fig. 15), is subpentagonal to roughly stellate compared with the roughly circular shape of *M. torehinaensis*. *A. bruennichi* further differs from *M. torehinaensis* in having a centrodorsal cavity that is subpentagonal, possesses interradial and radial ridges that are not as wide but are higher and more broadly rounded, and has more overlapping interradial points with markedly embayed centrodorsal interradial edges and pronounced radial ridges.

The thecae of *A. brydonei* (Fig. 8) possess a similar conical centrodorsal to that of *M. torehinaesis*, but have larger interradial points, and no cirrus-free dorsal area. Instead of the raised, rounded radial and interradial ridges of *M. torehinaensis*, *A. brydonei* has larger cirri sockets with marginal, raised rounded lips that form the radial and interradial ridges. *A. bellilensis* (Vallette, 1935) (Fig. 16), has a more roundly arched centrodorsal than *M. torehinaensis,* with no cirrus-free dorsal area. The centrodorsal of the thecae of *A. semiglobularis* (Nielsen, 1913) (Fig. 17), differs from *M. torehinaensis* by being roundly arched instead of conical, is ventrally subpentalobate with projecting interradial points, has broad, truncated oval to circular cirrus sockets in irregular vertical columns of five with a small, pustulose, cirrus-free dorsal area, and radial muscular fossae that are higher in *M. torehinensis*.

The centrodorsal of *A. pyropa* (Zahalka, 1832) (Fig. 18), is truncated conical and not as rounded-conical nor as long as in *M. torehinaensis*. The centrodorsal ventral face of *A. pyropa* is more oblong to subcircular than in *M. torehinaensis*, has thin basal furrows that enlarge distally instead of tapering, and has rounded, irregular radial impressions which is lacking in *M. torehinaensis*. Radial and interradial lateral ridges are higher, more sharply defined in *A. pyropa* than in *M. torehinaensis*, and instead of a cirrus-free dorsal area there is a dorsal pit. The centrodorsal of the thecae of *A. rugiana* (Gislén, 1924) (Fig. 19), differs from that of *M. torehinaensis* by being shorter, more sharply conical, with fewer cirrus sockets and by not having a cirrus-free dorsal area. The centrodorsal of *A. parva* (Gislén, 1924) (Fig. 20), is truncated conical, considerably shorter in length, with broader basal furrows than in *M. torehinaensis*. It is embayed at the radial edge, has a much larger centrodorsal cavity, possesses rugose radial and interradial ridges that are irregular, not straight, and has a flat not conical cirrus-free dorsal area.

Morphology of the Late Cretaceous atelecrinids *Jaekelometra meijeri* Rasmussen, 1961 (Fig. 21) and *J. concava* (Schlüter, 1878) (Fig. 22) is similar to that of *M. torehinaensis*. Both species described by Rasmussen (1961) have conical centrodorsals, similar sized, semi-circular to circular cirrus sockets bordered by zig-zagging radial and interradial ridges as in *M. torehinaensis*. However, they also have 10 columns of 2-6 cirrus sockets, which separates them from *M. torehinaensis*.

M. torehinaensis differs from other comatulids by having a centrodorsal that is not embayed at the radial periphery, has a moderate, subcircular, centrodorsal cavity on the ventral face, has indistinct broad basal furrows that do not change size distally. The centrodorsal possesses vertical irregular radial and interradial ridges that are broadly rounded, separating 15 columns of 2-4 circular cirrus sockets arranged regularly in lateral circlets, increasing in size toward the radials.

DISCUSSION

Well preserved, entire fossil comatulid specimens are unknown in New Zealand. In addition to those in the Torehina Formation, many comatulid centrodorsals have been collected from shallow water Oligocene limestone localities in the South Island (Eagle, unpublished), all in association with benthic pelmatazoans. Unlike the endemic species described in this paper, known South Island genera have a largely Tethyan affinity. The occurrence of two New Zealand Cenozoic tropiometraceans living with stalked crinoids in a shallow, innershelf environment (no more than 30 m deep), conflicts with the fossil record elsewhere in the world. Northern hemisphere models (Bottijer & Jablonski 1988) suggesting stalked crinoid movement offshore to deeper water in the Triassic, are contrasted by the inner-shelf late Oligocene comatulid-pelmatazoan association at Waitete Bay (Eagle 1993). The Waitete Bay comatulid taxa may simply be opportunistic as a result of climate warming, Indo-Pacific inward migration, the regional late Oligocene marine transgressive sequence, radiation within a New Zealand refugium, a response to tiered feeding within an ecological niche, or a combination of these. Whatever the cause, these comatulids are the remains of an unusual crinoid community selectively preserved within the limestone biofacies. In the context of New Zealand crinoid evolution, the fauna is important for several reasons. Both species described here belong to a superfamily today found in warm waters of the Pacific Ocean, with possible direct evolutionary relations. The Waitete Bay taxa are so far, the only recorded evidence of fossil comatulid communities in New Zealand.

Acknowledgements. Thanks are due to Geoff Gillard for donating the first comatulid specimen from Waitete Bay, and to Glenys Stace (Auckland Museum) for assistance in the field. Jack Grant-Mackie and Neville Hudson (University of Auckland, Geology Department) kindly read the draft manuscript and gave helpful suggestions. Referee comments were appreciated. The photographs are by Krzysztof Pfeiffer. The paper was supported by the Auckland War Memorial Museum.

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A NEW SPECIES OF *COTTREAUASTER* (ASTEROIDEA: ECHINODERMATA) FROM THE MIDDLE JURASSIC OF NEW ZEALAND

MICHAEL K. EAGLE

Abstract. A new asteroid, *Cottreauaster opuatiaensis* (Goniasteridae), is described from a partial specimen preserved in a middle to outer-shelf deposit of the Wilson Sandstone (Late Temaikan Stage; Bajocian), Ponganui, Port Waikato, New Zealand. It is a diminutive sea star, with the genus previously known only from the Northern Hemisphere. The record greatly extends the known distribution of the genus, indicating a Tethyan link in the Middle Jurassic, when New Zealand's palaeogeographic location was in high latitudes off the eastern coast of Gondwana. It is the second asteroid to be described from Port Waikato, and from the Jurassic of New Zealand.

KEYWORDS: Asteroidea; Valvatida; Goniasteracea; Goniasteridae; *Cottreauaster*; new species; Middle Jurassic; Bajocian; Temaikan; Wilson Sandstone; Port Waikato.

INTRODUCTION

A single near-complete fossil sea star was collected by the author from the Middle Jurassic Wilson Sandstone (Kear 1966), during a field trip to Ponganui, Port Waikato, in March 1998. The articulated specimen was collected *in situ* 2 m above the base of Opuatia Cliff, which is near the junction of a north-western tributary with Opuatia Stream (Fig. 1). The calcareous Wilson Sandstone is composed of mainly fine sandstone intercalated with lenses of coarse tuffaceous sandstone and interbedded concretionary layers of grey-brown siltstone. The Wilson Sandstone is of variable thickness, ranging up to 480 m at Te Akau, thinning northwards to 135 m in the Te Maire area, and reducing to 15 m at its northern extremity at Klondyke Road. The formation is distinguished in the Klondyke Road area by the incoming of the first sandstone above Putau Sandstone (Kear 1966). The fossil locality is interpreted as being a mid-shelf to slope (100-400 m deep) marine deposit that crops out along an inland exposure immediately south of Klondyke Road, Port Waikato (Fig. 1).

SYSTEMATICS

Taxonomy follows that of Spencer & Wright (1966) and Blake (1987).

PHYLUM:	ECHINODERMATA Bruguière, 1791
SUBPHYLUM:	ASTEROZOA Zittel, 1895
CLASS:	STELLEROIDEA Lamarck, 1816
SUBCLASS:	ASTEROIDEA de Blainville, 1830
ORDER:	ALVATIDA Perrier, 1884
SUPERFAMILY:	GONIASTERACEA Blake, 1987

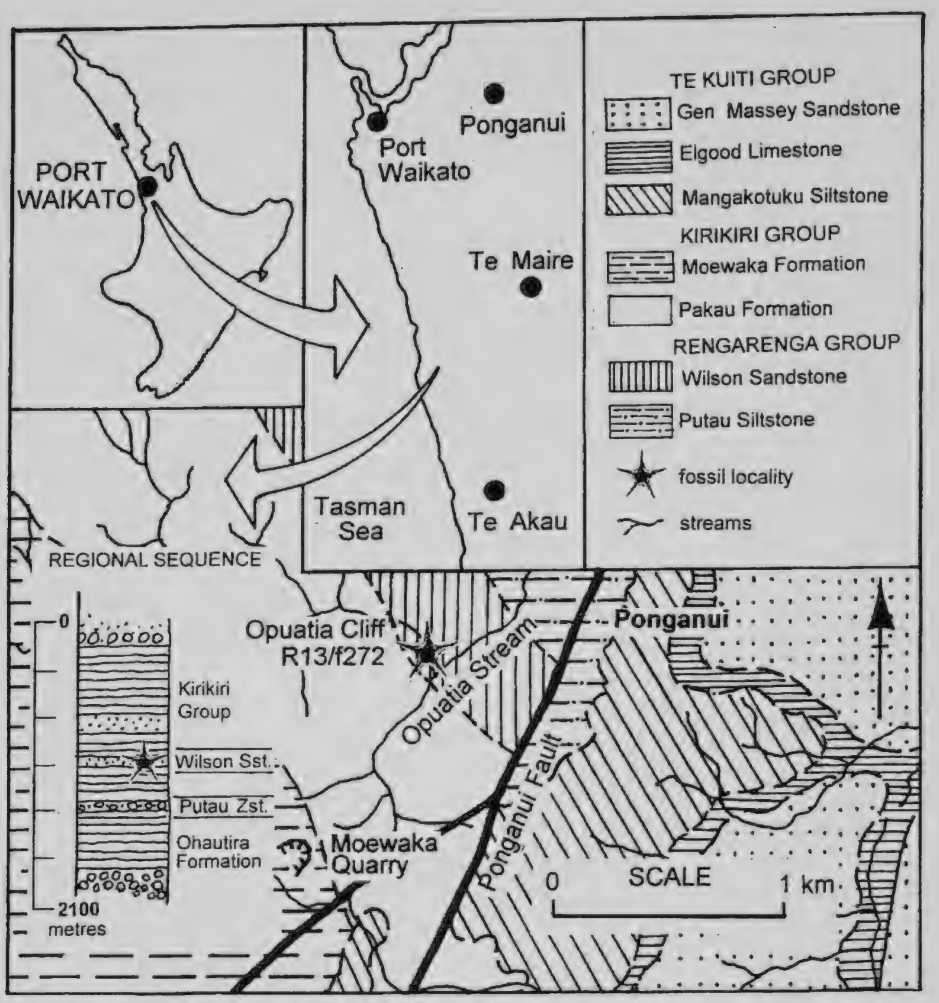


Fig. 1. Geological map showing the type locality (R13/f272) of *Cottreauaster opuatiaensis* at Opuatia Cliff, Ponganui, Port Waikato.

FAMILY: GONIASTERIDAE Forbes, 1841

Diagnosis. Pentagonal to narrowly stellate, generally with large disc; marginals well-differentiated, opposite, normally without specialised interradial marginals; plates on both actinal and abactinal surfaces in close contact; aboral plates flat, tumid, tabulate or paxilliform, with or without spines or granules; pedicellariae most commonly alveolate or valvate (Spencer & Wright 1966).

SUBFAMILY: GONIASTERINAE Forbes, 1841

Diagnosis. Pentagonal to stellate, often long-armed; genera with few, large marginals, normally with sunken edge; raised smooth or distinctly granulate central area; aboral plates may be flat, smooth, granulate or papillate, or raised round tubercles; specialisation of distal supramarginals may represent >7 marginals fused into enlarged ultimate supramarginal (Spencer & Wright 1966).

GENUS: *Cottreauaster* Wright, 1951

Type species. *Spenceraster lamarei* Cottreau, 1929 (O.D).
Age and distribution. Middle Jurassic (Bathonian), Orne, France.

Diagnosis. "Disc small, arms long, narrow, straight-sided, flexible; marginals small, tumid with fine granules; supramarginals with tubercles or spines, aboral plates irregular" (Spencer & Wright 1966: U61).

REMARKS

Cottreauaster was erected to replace the junior homonym preoccupied by *Spenceraster* Lambert, 1913. Until now *Cottreauaster* has been a monotypic genus confined to the Middle Jurassic (Bathonian) of Europe and found only at one locality in northern France (Cottreau 1929; Spencer & Wright 1966). The New Zealand Middle Jurassic sea star from Port Waikato is most similar to *Comptonia* Gray, 1840 (Aptian—Late Albian)), *Noviaster* Vallette, 1929 (Bathonian), and *Cottreauaster* Wright, 1951 (Bathonian). Like the New Zealand fossil sea star, *Comptonia* has arms that are long and slender, with slightly curved interradial arcs. However, the New Zealand specimen, unlike *Comptonia*, does not have square marginals in wide interrays, nor does it have fine, close spine pits on them. *Noviaster*, like the New Zealand specimen also has long, straight-sided arms that are moderately wide at the base, has rounded interradial arcs, and prominant carinals in three rows (reduced to one distally). The New Zealand sea star differs from *Noviaster* by not having marginals with large tubercles on faces between adjoining ossicles, and fine, hexagonal pits on the surface. Additionally, marginals in *Noviaster* are unlike those of the New Zealand specimen in that they are distinctly skewed, tumid, and oriented longitudinally at right-angles to the mid-line of the arm. The New Zealand fossil sea star is placed in the genus *Cottreauaster* because it has a small disc; arms that appear long and straight-sided; marginals that are small and tumid, with fine granules; and aboral paxillae that are irregular in outline.

Cottreauaster opuatiaensis n. sp. (Figs 3, 5, 6)

MATERIAL

Holotype. An external cast of the aboral side with the disc having one marginal and oral ossicle preserved. The distal portions of the arms are missing, and much of the animal, including elements of the skeleton, have been replaced by iron oxide. The specimen is deposited in the type collections of the Marine Department of the Auckland War Memorial Museum (AK73176).

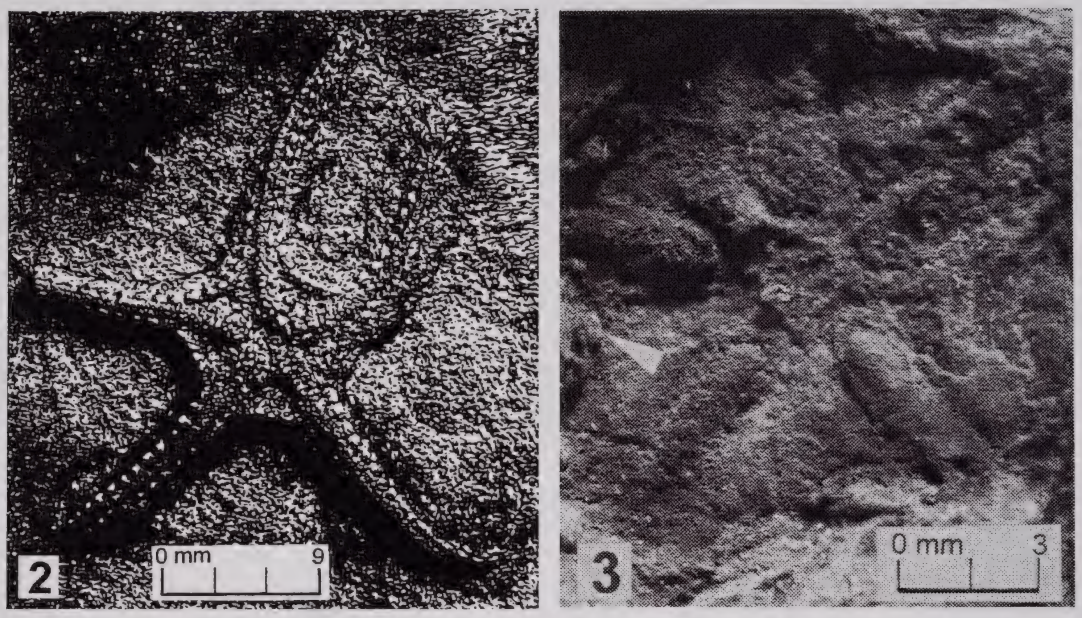
TYPE LOCALITY

New Zealand Geological Society Fossil Record File number R13/f272; grid reference R13/722270 (1979, NZMS 260, 1:50 000 map); 2 m above base of Opuatia Cliff, Pongonui, Port Waikato, South Auckland.

Diagnosis. Disc pentagonal with minute, regularly arranged paxillae on abactinal surface; marginals quadrangular, small, rounded, covered in fine granules; carinals arched in three rows along mid-line terminating in ossicle assemblage aboral ray surface.

DESCRIPTION OF HOLOTYPE

Body flattened, stellate; disc small, pentagonal; arms five, long, narrow, straight-sided, distinct from widely curved interradial arcs; marginals opposite, small, prominent, rounded quadrangular, uniform, tumid with fine granules; supramarginals covered in fine granules; carinals arched,



Figs 2-3. Abactinal views of *Cottreauaster* showing shape, paxillae and supramarginal ossicles and impressions. 2. Holotype of the type species, *C. lamarei*. 3. Holotype of *C. opuatiaensis* n. sp. (quadrangular supramarginal ossicle arrowed). (Fig. 2 from Cottreau 1929.)

prominent, three parallel rows along midline of aboral surface of ray, terminating proximally in large, round, inflated ossicle-assemblage covered in thin, granulose, organic membrane; relatively large, even interradials with irregular, minute, rounded abactinal paxillae, regularly arranged in interlocking pattern, densely packed in rows as series of chevrons meeting along arm midline; arrangement of rows of mid-arm paxillae regular; median paxillae slightly enlarged; orientation of rows of paxillae to arm midline 36°; intermarginal furrow development wide, deep; actinal surface with single oral preserved, otherwise unknown except for deep, large, circular oral cavity at disc centre; oral ossicle elongate oval with middle groove. Note: Paxillae are minute and do not show well in Fig. 3.

Measurements. Arm width between midpoints of interbrachial arcs 3.9 mm; radius (length of ray from disc centre to arm tip) 16.3 mm; arm length (estimated distance from the intersection of the line between adjacent interbrachial midpoints with the midline of the arm to the arm tip) 11.7 mm; diameter of largest paxillae 10 μm; disc diameter 6.5 mm; ratio arm width to arm length = 0.33:1.

AGE

The presence of Bajocian ammonites (Westermann *et al.* 2000) in the same sediments as the specimen of *C. opuatiaensis* confirms a Late Temaikan (Bajocian) age.

ETYMOLOGY

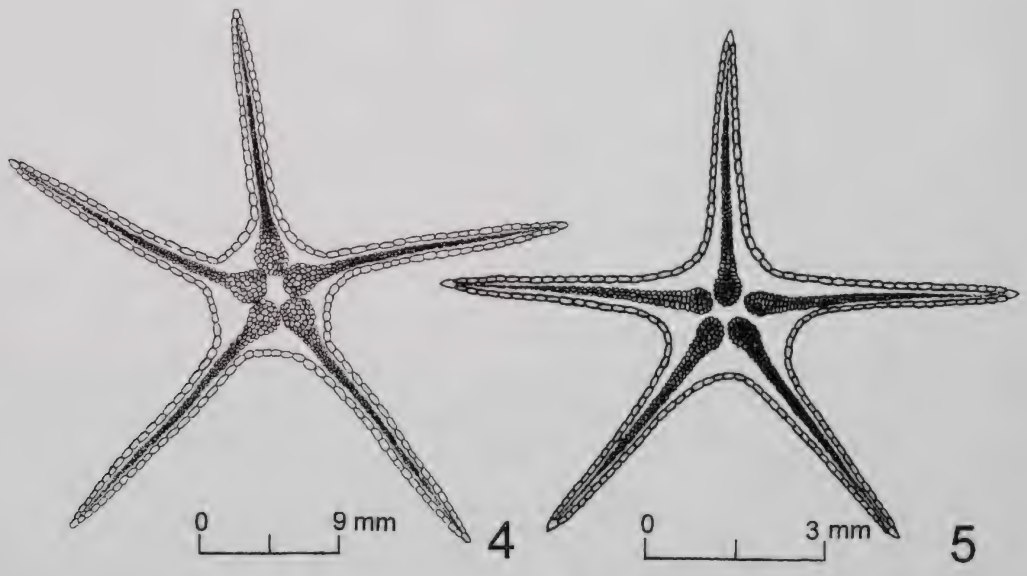
For the type locality, Opuatia Cliff, Ponganui, Port Waikato.

REMARKS

In valvatidans such as *Cottreauaster*, marginals, where differentiated, provide the guide to recognition (Blake 1987). Marginals originate as a typically double series lateral and actinal to the terminal and they are differentiated by size, alignment, or position (Blake 1987). The single marginal ossicle preserved in *Cottreauaster opuatiaensis* is important for these reasons, as is the overall body form. "Based on overall body form, representatives of certain sea star families can be distinguished at a glance ... These body shapes are considered to represent unified character complexes evolving as integrated wholes, and they are therefore treated as single characters " (Blake 1987: 485).

Allowing for incomplete preservation and consequent difficulty in taxonomic assessment, *Cottreauaster opuatiaensis*, although morphologically similar to *Comptonia comptoni* (Forbes, 1848) (England—Aptian / Late Albian), lacks the small, square marginals on the arms and the short, wide marginals in interrays of that genus. *C. opuatiaensis* has smooth, fine granules on marginal ossicles instead of the fine, close spine pits of *Comptonia comptoni*. *Noviaster lissajousi* Valette, 1929 (England, France—Bathonian), is also similar morphologically to *C. opuatiaensis* but posseses distinctly skewed marginals and three rows of carinals terminating in a large proximal tumid oval ossicle, which *C. opuatiaensis* does not.

C. opuatiaensis is morphologically most similar to the type species *C. lamarei* (Figs 2, 4), but differs in several respects. The disc diameter of *C. opuatiaensis* is about half that of *C. lamarei* at 12 mm. The arm length of *C. lamarei* (15 mm), is slightly larger although arm width is similar in both species (4 mm in *C. lamarei*). The marginals of *C. opuatiaensis* are proportionally similar to those of *C. lamarei*, but the interradial area is slightly larger (though this may be due to compaction). The smaller disc, slightly larger interradial area, shorter arm length, smaller, rounded quadrangular marginals with granules, irregular paxillae regularly arranged in chevrons at interradials, and three rows of arched carinals terminating proximally in an oval assemblage



Figs 4-5. Comparison of reconstructed *Cottreauaster lamarei* (4) and *C. opuatiaensis* (5) showing differences in disc outline, arm length, and arm mid-line carinals. (Fig. 4 after Spencer & Wright 1966.)

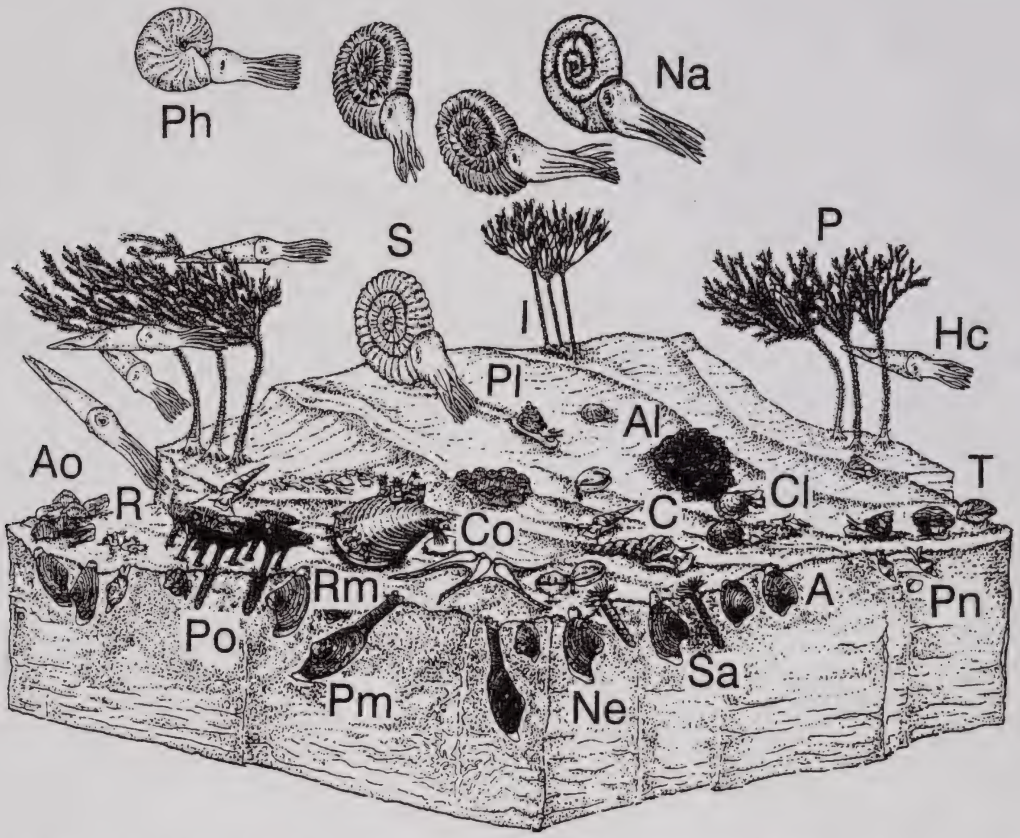


Fig. 6. Schematic drawing of the assumed mid-shelf to slope biocoenosis (100-400 m) at Opuatia Cliff, of which *Cottreauaster opuatiaensis* may have been a member. No scale implied. A = *Astarte* sp. (Bivalvia); Al = *Aucklandrhynchia lavis* (Brachiopoda); Ao = *A. opuatiaensis* (Brachiopoda); C = *"Cerithinella"* sp. (Gastropoda); Cl = *Camptonectes* cf. *laminatus* (Bivalvia); Co = *Cottreauaster opuatiaensis* (Echinodermata); Hc = *Hibolithes catlinensis* (Cephalopoda); I = Isocrinidae gen. & sp. indet. (Echinodermata); Na = *Nanolytocerous* sp. (Cephalopoda); Ne = *Neocrassina* sp. (Bivalvia); P = Pentacrinidae gen. & sp. indet. (Echinodermata); Pn = *Palaeonucula* sp. (Bivalvia); Ph = Phylloceratidae gen. & sp. indet. (Cephalopoda); Pl = *"Pleurotomaria"* sp. (Gastropoda); Pm = *Pleuromya milliformis* (Bivalvia); Po = Pogonophora sp. (Annelida); R = *Rotularia* sp. (Annelida); Rm = *Retroceramus marwicki* (Bivalvia); S = Sphaeroceratidae genera & spp. (Cephalopoda); Sa = Sabellidae gen. & sp. indet. (Annelida); T = Terebratulid gen. & sp. indet. (Brachiopoda). Associated biota drawn after McKerrow (1978).

of ossicles, differentiate *C. opuatiaensis* from *C. lamarei.* These characters also differentiate *C. opuatiaensis* from other known fossil or Recent goniasterids.

DISCUSSION

The collection of a second Jurassic sea star a short distance from the type locality of a slightly younger *Odontaster priscus* Fell (Odontasteridae: Heterian Stage / Bathonian), Moewaka Quarry, Ponganui, points to exceptional preservational circumstances at both localities at different times.

Both sea stars are of similar depth range but different environments. They are very small, although each is typical in size for its genus. *Cottreauaster opuatiaensis* and *Odontaster priscus*, so far as can be ascertained, readily fit modes of life established for modern sea stars. *C. opuatiensis* and *O. priscus*, being found on soft substrates among other benthic invertebrates, are thought to have been detrital and carnivorous feeders on benthic protozoans, crustaceans, small molluscs, and polychaetes. It is possible that, because of the small size of *C. opuatiaensis*, the Opuatia Cliff specimen has been introduced either living or postmortem into the fossil locality by an offshore sediment gravity flow, or by failed predation. However, preservation of numerous benthic invertebrates at the Opuatia Cliff locality (Westermann *et al.* 2000) suggests *C. opuatiaensis* may also have fossilised *in situ.* The biocoenoses of both fossil localities includes bivalves, gastropods, scaphopods, polychaetes, ammonites, brachiopods, and crinoids. The high molluscan diversity at the Opuatia Cliff locality (Westerman *et al.* 2000) indicates a water depth of 100-400 m (mid-shelf to slope; J.A. Grant-Mackie pers. comm.) (Fig. 6) east of the Antarctic coast of Gondwana, 60° south, enjoying temperate seas of moderate salinity, constrained by about four months of darkness (Stevens *et al.* 1988).

Though a large proportion of the known fossil Asteroidea are assigned to the Valvatida (Spencer & Wright 1966), knowledge of the phylogeny of genera and species is limited. Goniasteracea of Blake (1987) are known from Early Jurassic to Recent. However, fossil sea stars in New Zealand are rarely found intact (Eagle 1999), and the record of *Cottreauaster* in New Zealand, almost antipodal to northern France, greatly extends the known distribution of the genus. It again fulfills the prediction made by Fell (1952: 146) that "it now begins to look as if we may expect to find other parallels between the Mesozoic echinoderms of Europe and New Zealand despite the present lack of corresponding fossil records from intervening points on the globe". Speden (1959) provided the first confirmation by describing New Zealand's only cyrtocrinid, *Phyllocrinus furcillatus* (late Tithonian), previously known only from Europe (also from France). A Jurassic Tethyan link is suggested by the presence of *Phyllocrinus furcillatus* and *Cottreauaster opuatiaensis* in New Zealand. The New Zealand Late Temaiken Stage (Bajocian) *Cottreauaster* record predates the French occurrence (Bathonian) by c. 5 million years.

Acknowledgements. I am indebted to Jack Grant-Mackie (Geology Department, University of Auckland), Peter Jell (Queensland Museum), Fred Hotchkiss, and Daniel Blake (Geology Department, University of Illinois), and an anonymous referee, for useful comments, including reading of the manuscript. Thanks are also due to the Begg family of Ponganui, who have always given free access to the fossil localities on their property. Research was supported by the Auckland War Memorial Museum.

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VOLUME 38

MR CHEESEMAN'S LEGACY: THE AUCKLAND MUSEUM AT PRINCES STREET

RICHARD WOLFE

Abstract. The Auckland Museum occupied its first purpose-built premises, in Princes Street from 1876 to 1929, on what is now the site of the Hyatt Regency Auckland hotel. Present understanding of this, the institution's fourth home, is restricted to annual reports of the Auckland Institute and Museum, and a modest archive of photographs, publications and other documents. Under curator Thomas Cheeseman this was a remarkably active museum, the original building receiving three major extensions in 30 years before outgrowing its site. These physical developments are detailed in the following reconstruction, showing significant changes to the Museum's collections and public galleries.

KEYWORDS: Museum history; ethnology; natural history; T.F. Cheeseman; John Logan Campbell; antique statues; Russell Bequest; School of Design/Free School of Art; Grey Collection; Mackelvie Collection; Kaitaia carving.

INTRODUCTION

If the nineteenth century has been labelled the Museum Age, 1852 was a particularly busy year. In addition to the founding of the South Kensington (now the Victoria and Albert) Museum in London and the Hermitage Museum in St Petersburg (McAlpine & Giangrande 1998: 24), there was a significant development on the other side of the world. Auckland Museum first opened its doors to the public in October 1852 (Park 1999) in a disused Government farm building at the north-eastern corner of Symonds Street and Grafton Road. The site of one of New Zealand's earliest museums is now part of the grounds of Auckland University, and was marked by a plaque on Auckland Museum's 140th birthday in 1992.

The new Museum reported a successful first year, receiving 708 visitors. But this early promise was short-lived, and by 1867 its "rudimentary" collection and "handful of books" had been moved to its second home, in what later became a smoking room in the Northern Club building in Princes Street. The following year saw the formation of the Auckland Institute and Museum, which applied for the use of the building adjoining the old Post Office nearby (Powell 1967: 11-13). On 14 September 1869, thanks to the persistence of Mr Justice Gillies, then Superintendent of Auckland, the Institute obtained this property under the Public Reserves Act of 1854 (Cheeseman 1917: 1; Book 21, vol.10G, Crown Grants, Land Information New Zealand, Auckland). By early 1870 the Museum and its associated Library had been transferred to this, its third home, and in the following year the Institute announced plans for a building fund (Powell 1967: 12). There was a degree of urgency, for the old Post Office premises had become "dilapidated", "mean and uninviting in appearance" and "far from weatherproof" (Ann. Rep. 1872: 7; 1873: 8) and in June 1871 a large portion was dismantled (Ann. Rep. 1872: 7).

Throughout this paper, "Ann. Rep." refers to the *Annual Report of the Auckland Institute and Museum*, first published in 1871. Table 1 presents a summary of the development of exhibits

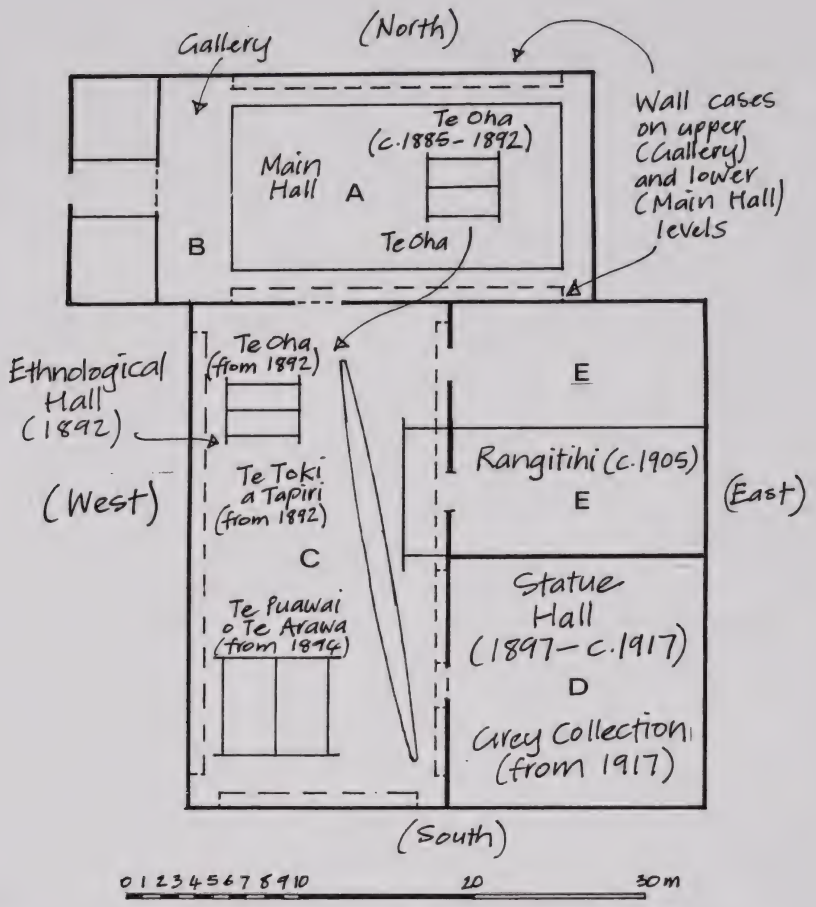

Fig. 1. Floor plan of Auckland Museum at Princes Street, 1876 – c.1928. The location and size of wall cases and significant artefacts is approximate. The letters A-E refer to Table 1.

Table 1. Summary of the development of exhibitions and displays in various parts of the Auckland Museum at Princes Street. The letters A-E refer to the floor plan (Fig. 1).

A. Main Hall (Ground Floor), opened 1876

1876: Opening "Art & Industrial Exhibition" (Ann. Rep. 1876-7: 7).

Late 1870s:
Ratite skeletons, "stuffed" birds, heads of North American deer.

1878: Arrival of antique statues and busts (Figs 3-9).

c.1878: Showcases built on south wall for birds and mammals (Ann. Rep. 1878-9: 10); arrival of large carving Pukaki (Ann. Rep. 1877-8: 10).

c.1879: Arrival of giraffe skeleton (Ann. Rep. 1879-80: 9, Fig. 4).

c.1880: Arrival of alpine birds and mammals from Geneva, and rocks from London (Ann. Rep. 1880-81: 8-9, Fig. 9).

c.1884: Display cases financed by Costley bequest (Fig. 10).

1885: Arrival of war canoe Te Toki a Tapiri. Until 1892 it was placed in an annexe erected at the south side of the building (Ann. Rep. 1885-6: 7, 1886-7: 7, Fig. 11).

c.1885: Arrival of small pataka, Te Oha (Ann. Rep. 1885-6: 7, 1886-7: 7, Fig. 10).
c.1893: Rearrangement of mammals and foreign birds; showcase installed for moa bones (Ann. Rep. 1893-4: 7).
c.1894: Rearrangement of foreign birds, minerals and New Zealand fossils (Ann. Rep. 1894-5: 8).
c.1897: Mammals in cases on south wall, foreign birds at north and east ends (Ann. Rep. 1897-8: 7, 1898-9: 8).
c.1898: New cases for larger animals (Ann. Rep. 1898-9: 8-9).
c.1900: Invertebrata, shell and New Zealand bird displays refurbished (Ann. Rep. 1900: 1-7).
c.1904: Arrival of first group of larger animals: lions and cubs (Ann. Rep. 1904-5: 8).
c.1905: Arrival of pair of tigers and leopard (Ann. Rep. 1904-5: 8); installation of large showcase for birds and animals, mainly from Canada (Ann. Rep. 1905-6: 8).
c.1906: Arrival of polar bear and musk oxen; displayed in centre of hall (Ann. Rep. 1907-8: 8).
c.1907: South African animals displayed at east end (Ann. Rep. 1907-8: 8).
1912: Restored moa; group of birds of paradise; common shag habitat (Ann. Rep. 1912-3: 8-9).
c.1914: Spotted shag habitat (Ann. Rep. 1914-5: 8).
c.1915: North Island kiwi habitat (Ann. Rep. 1915-6: 10).

B. Gallery (First Floor, Main Hall), opened 1876

c.1881: Paintings from Mackelvie and (from c.1883) Grey Collections displayed on north gallery until c.1888 (Ann. Rep. 1881-2: 7, 1883-4: 8).
1891: New cases installed on north gallery for Gilbert Mair collection.
c.1898: Minerals displayed in wall cases on south side, New Zealand birds on north side, moa and extinct New Zealand birds on west, fish on east. Desk cases of minerals surround gallery (Ann. Rep. 1898-9: 8-9).
c.1906: Shelving and wire guards installed between pillars for alcoholic specimens (Ann. Rep. 1906-7: 9).
c.1908: Foreign shells moved up from ground floor (Ann. Rep. 1908-9: 7).
c.1910: New Zealand food fishes (68) installed (Ann. Rep. 1910-11: 7).
c.1915: Gallery now reserved entirely for New Zealand fauna – birds, fish, reptiles, shells and other invertebrata (Ann. Rep. 1915-6: 8).
c.1917: New Zealand shells in table cases at south wall (Ann. Rep. 1917-8: 8).

C. Maori Hall (Ethnological Hall, South Wing), opened 1892

1894: Installation of pataka Te Puawai o Te Arawa (Ann. Rep. 1894-5: 7, Fig. 16).
1898: Whole of Maori collection rearranged (Ann. Rep. 1898-9: 8-9).
c.1901: Further rearrangement of Maori collection with purchase of Mair collection (Ann. Rep. 1901-2: 7, 1902-3: 7).
c.1904: Dismantling of large portion of showcases on east side to give access to 1905 extension; rearrangement of anthropological collection (Ann. Rep. 1904-5: 8, Figs 15, 18).
1911: Te Kaha carvings enter collection, displayed at north end (Fig. 23).
c.1914: New displays on fishing and greenstone (Ann. Rep. 1914-5: 10).
c.1915: Gateway from Lake Okataina arrives (Ann. Rep. 1915-6: 9).
c.1917: Large part of Maori Hall rearranged (Ann. Rep. 1917-8: 5).
c.1918: Large carvings on east wall redisplayed on framework erected above existing cases, with similar improvements planned for west side (Ann. Rep. 1918:-9: 8, Fig. 21).

D. Statue Hall, opened 1897

c.1898: Statues refurbished, walls painted (Ann. Rep. 1909-10: 8, Fig. 20).
1917: Grey collection of Maori artefacts and foreign ethnology replaces statues (Ann. Rep. 1916-7:9); Pacific canoes (3) installed (Ann. Rep. 1916-7: 11, 1917-8: 9, Figs 24-26).

E. 1905 Extension

c.1905: Meeting house Rangitihi installed (Fig. 21).
c.1906: Polynesian ethnological material (previously in Maori Hall) displayed in new space adjacent to Rangitihi (Ann. Rep. 1905-6: 8).
1916: Foreign ethnology removed, becomes Mineral Room (Ann. Rep. 1916-7: 9).

at Auckland Museum on the Princes Street site. Fig.1 is a floor plan showing the original Main Hall and all subsequent extensions.

1876-1891: A NEW BUILDING

In 1872 the Museum's governing Council proposed to use "rather less than one-half" of its property by "erecting thereon a galleried building extending from Princes Street to the rear". This scheme had an element of forward planning, with the building forming a portion of "one design for the entire site" (Ann. Rep. 1872: 7). Mindful of the need for fund-raising, a general meeting of the Council determined to increase its membership to eleven. The subsequent election of additional officers included two individuals who would shortly play a significant part in the development of the Museum: Auckland businessmen Dr John Logan Campbell and Mr Thomas Russell. Exhorting the influence and support of its members, the Institute's avowed aims at this time were to "advance the diffusion of knowledge, and to promote alike, pure taste, intellectual pleasure and material advancement" (Ann. Rep. 1872: 9).

By 1874 the Museum was enjoying increased visitor numbers inspecting its collections of "Type Minerals" and "Native Birds", but operating under difficulty (Ann. Rep. 1874: 6). After considering several other locations for the Museum the Council remained committed to the old Post Office site. Shortly, rough plans and estimates for a new building were prepared by "a competent architect", Phillip Herepath (Ann. Rep. 1874-5: 8; Museum Scrapbook). His plans incorporated a roof lantern for natural lighting, and a gallery – or first floor exhibition space – at the perimeter of the Main Hall (Ann. Rep. 1875-6: 6).

Auckland Museum's first new building was completed and handed over by the contractor in May 1876, and officially opened by His Excellency the Governor, the Marquis of Normanby, on 5 June. The event was marked by an Art and Industrial Exhibition, combined with a series of popular scientific lectures. The new start was reportedly modest, its opening exhibition being "somewhat unequal in character" and bearing "manifest evidences of the haste with which it had been organised" (Ann. Rep. 1876-7: 7). The Council also regretted that "from the want of new cases and other requisites, it has not been possible to display some of the specimens in as full a manner as could be wished" (Ann. Rep. 1876-7: 10).

The Auckland Museum's address was 2 Princes Street, on the corner of Eden Crescent and at the top of Shortland Street. The lower (northern) corner of the site was occupied by the caretaker's cottage, and next to this was another wooden building, most likely a remnant of the old Post Office whose site was taken for the 1876 building (Cheeseman 1917: 13). To the south of the latter lay another wooden house, which would shortly be purchased by the Council and make way for an expanding Museum.

The new building was of brick, presumably plastered to resemble stone construction, and had a two-storeyed frontage on Princes Street (Fig. 2). Although dimensions do not appear to have been published, a 1908 Auckland Gas Company plan (Fig. 22) and a 1919 Land Transfer Survey (Fig. 28) suggest the building may have been of identical in length – 100 ft (30.5 m) – and slightly narrower – approximately 45 ft (13.7 m) as opposed to 50 ft (15.2 m) – to the 1892 extension (Ann. Rep. 1892-3: 7).

Two windows flanked each side of the central main front door of the 1876 building, and five more pierced the upper level of its facade. Inside, to the left (north) of the front entrance was the office and herbarium of the Curator, Mr Thomas Frederic Cheeseman, which had a fireplace on its north wall (Fig. 3, Powell 1967: fig. 2). Opposite the curator's office was a similar sized room (see Fig. 3) whose function has not been recorded. The 1894 decision to "transfer the Library into the Lecture-room" (Ann. Rep. 1893-4: 8) suggests it may have been

Fig. 2. The Auckland Museum building in Princes Street, completed in May 1876 on the site of the old Post Office. A remnant of the latter survives between the new building and a dwelling which became the caretaker's cottage (far left). To the right is the house purchased by the Institute to provide room for the 1892 south wing or Ethnographic Hall. (Auckland Museum Library, C17017).

an early library. Alternatively, the Library may have been housed in the remaining section of the adjacent old Post Office building. Upstairs, spanning the full width of the west end of the building, was the room originally designated "Lecture-room". It was connected to the west gallery by two doors. There are no known photographs of this room when used for lectures, but three later views (Princes Street Album, Museum Library) record it as a well-stocked library.

Apart from the lecture room, the upper level of the Museum contained a four-sided gallery, with stair-cases at its north-west and south-west corners (Fig. 3). It was supported by columns – seven along the length and four across the width – which were repeated above the gallery level to the upper ceiling. Over these galleries the ceiling was flat, but between them and above the Main Hall it was vaulted and surrounded a deep natural light well. From the outside, an otherwise plain iron roof was relieved only by the central lantern structure. Additional natural lighting was provided by three tall windows at the eastern end of the building (Fig. 14).

In the early days at the new Princes Street building the collections were housed in cases from the "old Museum", most of which were considered both unsuited and inefficient (Ann. Rep. 1881-2: 8). In the late 1870s the displays benefited from the setting up of "skeletons of Dinornis, Rhea, &c." and special attention to the remounting of the "stuffed birds". New additions to the collections included "three magnificent stuffed heads of North American deer" and Pukaki, a "large and ancient Maori carving" (Ann. Rep. 1877-8: 10). The following year "about 300 birds and thirty mammals" were accommodated in a large show-case built along the south side of the Main Hall (Ann. Rep. 1878-9: 10).

PLASTER CASTS FROM ANTIQUITY

This period in the Museum's history was marked by a "truly magnificent donation" by Thomas Russell of plaster casts of antique statuary (Ann. Rep. 1878-9: 8). This collection of 22 full-size figures and 11 busts is discussed in detail, for several reasons. Further to a previously published perspective (Blackley 1988), the Museum's own archive provides details of the placement of the statues and their important part in the development of art education in Auckland. Certain of these statues would still be on public display 122 years later, and so qualify as some of the Museum's longest-serving exhibits.

On 5 August 1878, John Logan Campbell, informed the Council that Thomas Russell had advised him of the shipment (from England) of the antique consignment and asked to arrange the necessary pedestals so that the casts could be put in their "intended positions". "[B]eing aware that the funds of the Institute are not in a state to defray other than ordinary current expenses", Logan Campbell then offered to finance all the requisite "pedestals brackets etc" if entrusted with the placing of the casts in the Museum (Logan Campbell correspondence, Museum Archives). Also on 5 August 1878, Logan Campbell provided the Council with a list of the antique statues and busts on order, and suggested their arrival was the stimulus for the inauguration of a School of Design in Auckland. He noted that "such a school [was] much wanted" but the public was "not so impressed with the necessity" and so it was "still premature to make a move in the direction of erecting a building purely as a School of Art". Logan Campbell therefore proposed an interim solution, offering to pay the salary of an instructor and certain expenses, such as the cost of stools and easels. He suggested that Council could give permission for "copyists" to occupy the necessary space without interfering with the public's access to the Museum (Logan Campbell correspondence, Museum Archives). In a memorandum of understanding Logan Campbell listed eight points relating to the establishment of "a temporary School of Design at the Institute". The Hall of the Museum was to remain open to the public as before, but admission to the Lecture Room was to be restricted to pupils on "Class Days", being Wednesdays and Saturdays. While the public were entitled to "stand before a model & draw", only pupils and students were allowed to introduce stools and easels into the Museum Hall. Logan Campbell also required that no other instructor be awarded such privileges by the Council (Logan Campbell correspondence, Museum Archives).

Logan Campbell envisaged three distinct classes of students: "Copying, Drawing from casts and Figure or statue drawing". He also offered to provide "a small collection ... of minor subjects which will fittingly supplement the grand and imposing display of life sized statues ...." In addition to class sizes (limited to 15) and operating hours, Logan Campbell specified that in the event of a dispute his decision was to be final (Logan Campbell correspondence, Museum Archives).

In 1879 Logan Campbell personally addressed the Council, and his offer to provide "a competent instructor" and cover expenses in return for the use of the Lecture Room was accepted. His "School of Design" was soon in operation, with 20-30 students, and the results promised "to be in every way satisfactory" (Ann. Rep. 1878-9: 9). The tutor engaged by Logan Campbell was Auckland artist Kennett Watkins, who later painted background scenes for a number of the Museum's natural history displays (Wolfe: 1994 & 1998). Incidentally, one of Watkins' pupils was Miss Rosetta Keesing, who would later become Mrs. Cheeseman, wife of the curator (Powell 1967: 20).

Surviving photographs show the placement of the antique statues within the original Main Hall of the museum at two different periods. Both sets include a giraffe skeleton, presumably the specimen whose arrival was reported in 1880 (Ann. Rep. 1879-80: 9). The later set also

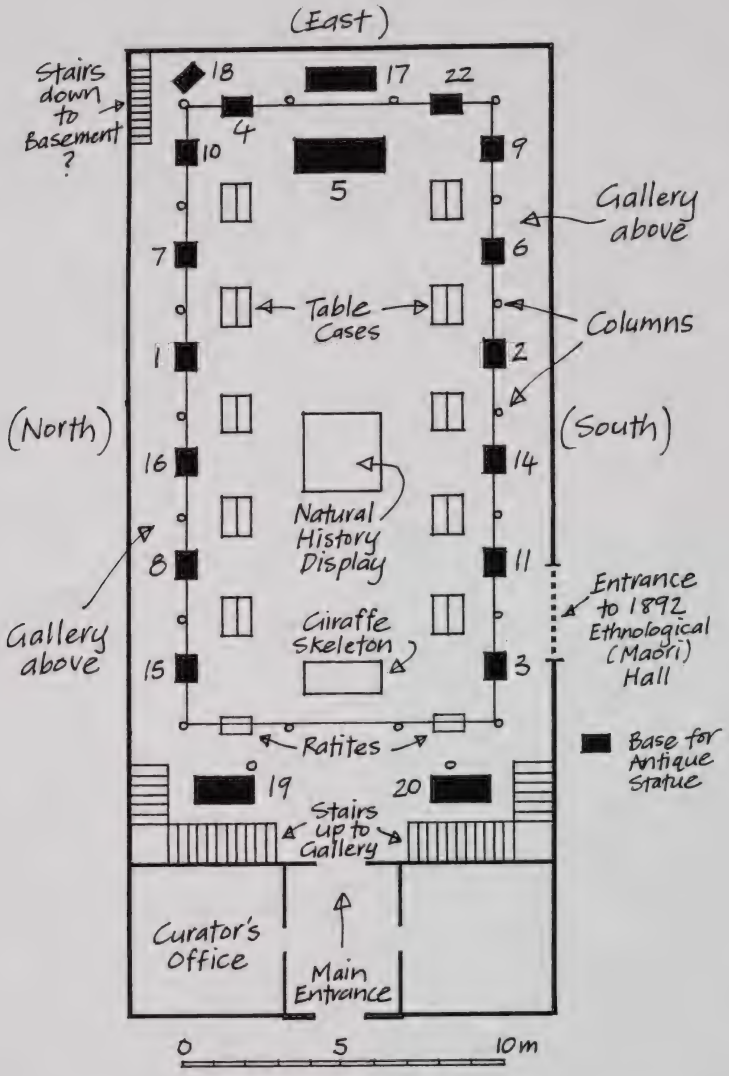

Fig. 3. Reconstruction of ground floor of Auckland Museum, early 1880s. The building is shown here as 100 ft (30.5 m) long by 45 ft (13.7 m) wide, with a 6 ft (1.8 m) wide upper gallery at the north, east and south sides of the Main Hall. At the entrance to the Main Hall proper were stairs up to the gallery, and the antique statues of Theseus (19) and Ilissus (20) to the left and right respectively. In front was the skeleton of a giraffe, flanked by those of ratites. In the centre of the Hall was a large natural history display, and beyond that the largest of the antique statues, Laocoon (5). The other statues were positioned between columns around the Hall, with a ring of table cases in front. Display cases (not shown) also lined the north and south walls of the Main Hall and, progressively, those of the upper gallery. The antique statues are numbered in order according to Logan Campbell's original list: 1. Venus de Medici 2. Venus de Milo 3. Apollo Belvedere 4. Apollino 5. Laocoon 6. Standing Discobolus 7. Discobolus 8. Adonis 9. Germanicus 10. Demosthenes 11. Polyhymnia 12. Euterpe (displayed on west gallery) 13. Young Bacchus (displayed on west gallery) 14. Antinous 15. Diana a la Biche 16. Fighting Gladiator 17. Dying Gladator 18. Dancing Faun 19. Theseus 20. Ilissus 21. Ganymede (displayed on west gallery) 22. Suppliant Youth.

includes the small pataka, Te Oha, donated by Mr Fenton, installed in the Main Hall in 1885-6 (Ann. Rep. 1885-6: 7, 1886-7: 7). The earlier photographs precede both the display of the Mackelvie paintings on the north gallery in 1881-2, and the installation of cases there for the Mair ethnographic collection in 1891, and must therefore date from the early 1880s. The other set, obviously later on account of growing congestion, date from between 1885-6 and 1892, when Te Oha was relocated in the new extension. In all these photographs the positions of the antique statues remain constant, at the perimeter of the Main Hall and west gallery. The busts either sat on brackets attached to the inside of the gallery at first floor level, facing into the Main Hall, or on pedestals at the west end of the gallery. The position of the statues (Fig. 3) has been determined from photographs, and the names given here correspond to those used by Logan Campbell in his letter of 5 August 1878. Accepted alternatives are also given, where applicable.

In the north-west corner of the hall reclined Theseus (Heracles, Olympos or Dionysus, from east pediment of Parthenon), with Diana a la Biche (Diana Chassereuse, Diana of Ephesus), Adonis, Fighting Gladiator (Borghese Gladiator), Venus de Medici, Discobolus (Discobolus of Myron), Demosthenes and Dancing Faun (Medici Faun) along the north wall (Figs 4,5,6).The largest statue, Laocoon, was logically centred at the eastern end of the hall, opposite the main entrance and in front of Dying Gladiator (Dying Gaul), with Apollino (Little Apollo or Medici Apollo) and Suppliant Youth in the north-east and south-east corners respectively (Figs 6,7). From the south-west corner of the west wall it is possible to identify Ilissus (from west pediment of Parthenon) – to balance the similarly reclining Theseus opposite the main entrance – Apollo

Fig. 4. Main Hall of Auckland Museum, looking towards main entrance, early 1880s. The antique statue on the extreme left is Antinous, with Polyhymnia and Apollo Belvedere to the right. The reclining Ilissus and Theseus are in the left and right corners of the hall, in front of the stairs. Diana a la Biche obscures Theseus, and to her left are Adonis and Fighting Gladiator. The bust of Jupiter looks down on the giraffe skeleton from the gallery. Behind are Young Bacchus (left hand corner) and Euterpe (right hand corner), while Ganymede is obscured by a bust. Two doors on the gallery lead to the Lecture Room, which later also became the Library. (Auckland Museum Library, C56638).

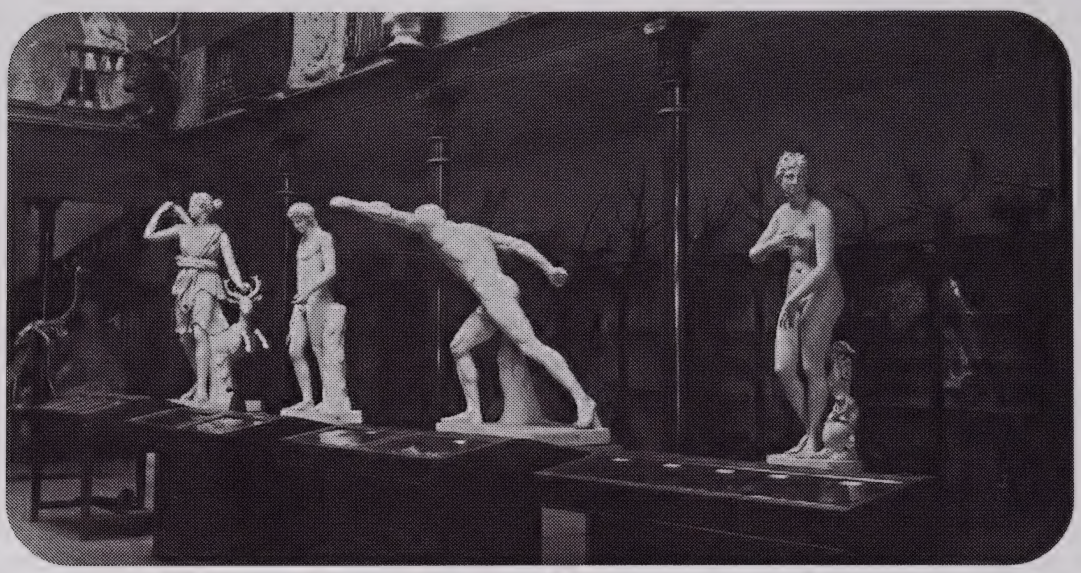

Fig. 5. North-west corner of Main Hall, Auckland Museum, early 1880s. The statues are (from left) Theseus (obscured by ratite skeleton), Diana a la Biche, Adonis, Fighting Gladiator and Venus de Medici. (Auckland Museum Library, C28285).

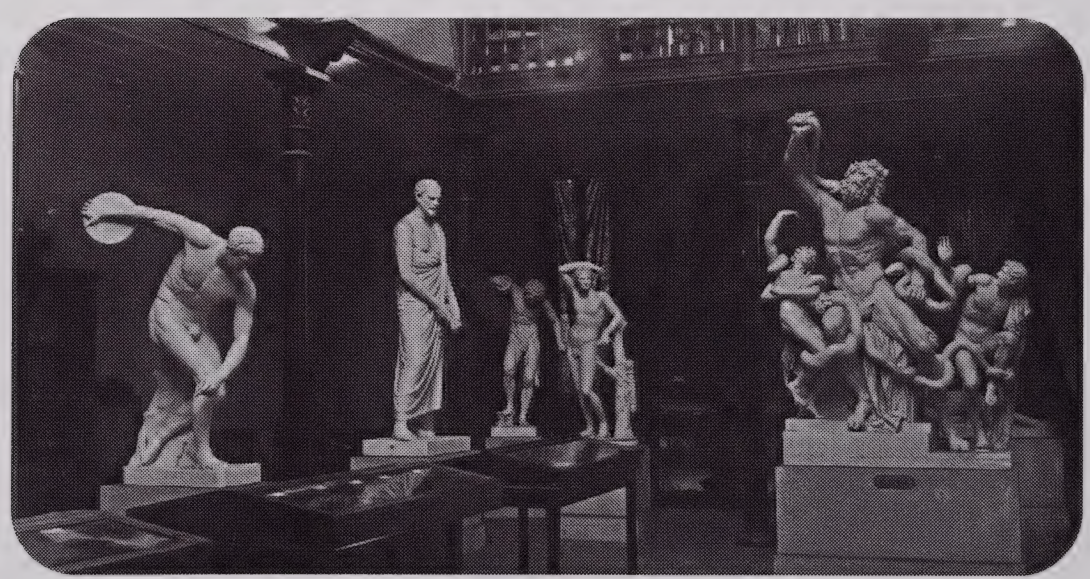

Fig. 6. North-east corner of Main Hall, Auckland Museum, early 1880s. The statues are (from left) Discobolus, Demosthenes, Dancing Faun (in corner), Apollino and Laocoon. The Dying Gladiator is obscured by Laocoon. What may be a newel post can be seen to the right of Discobolus, suggesting stairs to the basement. The back (east) wall of the hall is a storage area for Maori carvings. (Auckland Museum Library, C28292).

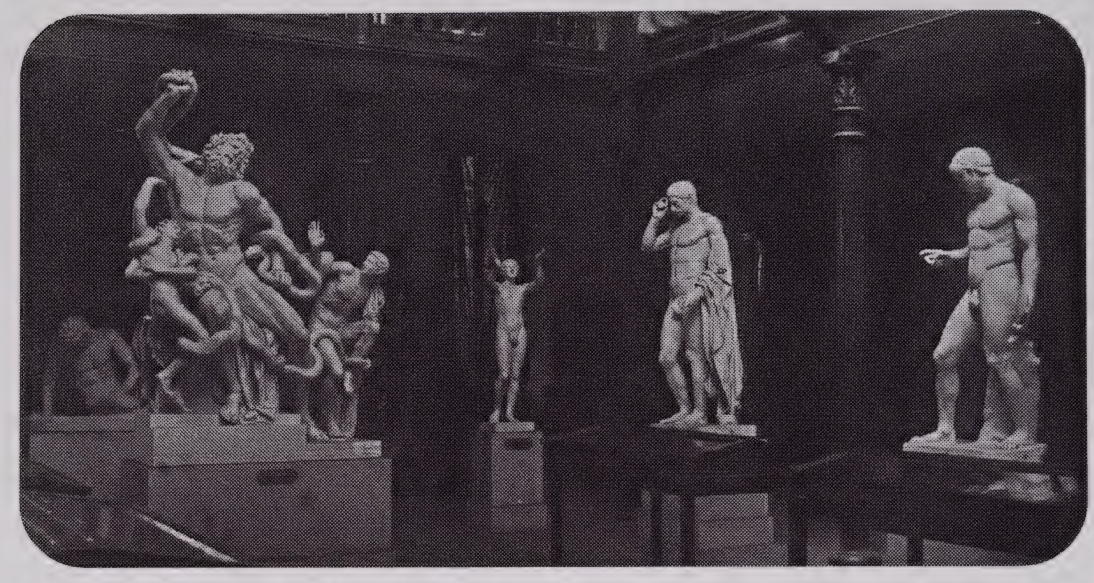

Fig. 7. South-east corner of Main Hall, Auckland Museum, early 1880s. The statues are (from left) Dying Gladiator, Laocoon, Suppliant Youth, Germanicus and Standing Discobolus. The distinctive large Maori carved figure of Pukaki can be seen against the back wall, between Suppliant Youth and Germanicus. (Auckland Museum Library, C28283).-

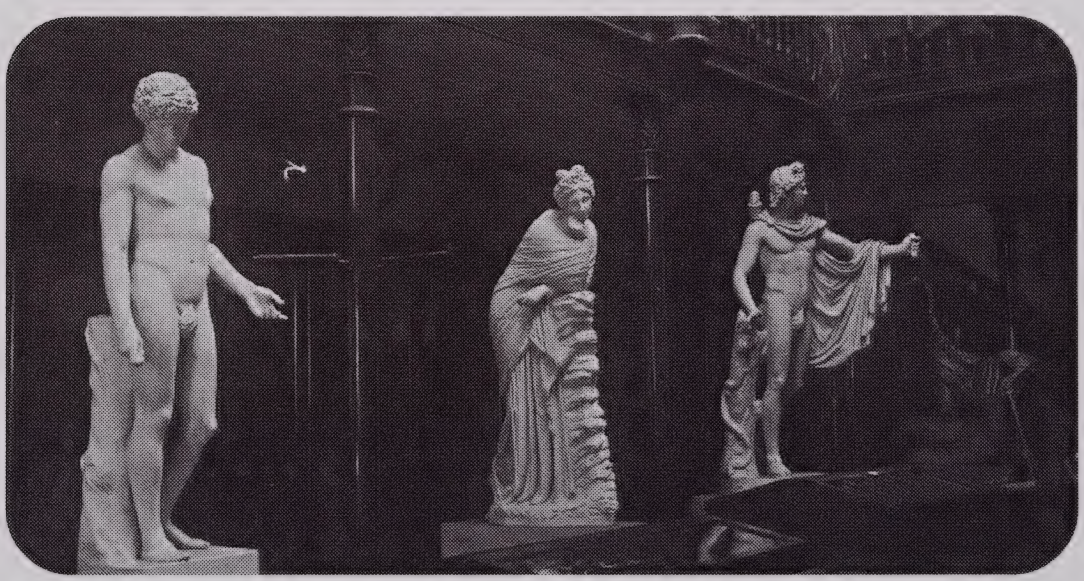

Fig. 8. South-west corner of Main Hall, Auckland Museum, early 1880s. The statues are (from left) Antinous, Polyhymnia, Apollo Belvedere and Ilissus (obscured by ratite skeleton). (Auckland Museum Library, C28289).

Fig. 9. Natural history display in Main Hall, Auckland Museum, early 1880s. These two views, looking north-east (left) and south-east, show the partly obscured Venus de Medici and Venus de Milo respectively. This display probably includes the alpine birds and mammals received from Geneva c.1880 (Ann. Rep. 1880-1: 8-9). (Auckland Museum Library, C6136 & C28282).

Belvedere, Polyhymnia and Antinous (Capitoline Antinous) (Fig. 4,8). From the south-east corner were Germanicus and Standing Discobolus (labelled as "Discobolus Naucydes"), in that order (Fig. 7).

Centrally located at the western end of the upper gallery outside the Library was Ganymede, with Young Bacchus and Euterpe to his right and left respectively (Fig. 4). The location of Venus de Milo – directly opposite Venus de Medici on the south side of the Main Hall – is given by a pair of photographs of a natural history display (Fig. 9), probably the alpine birds and mammals which had arrived by 1881 (Ann. Rep. 1880-1: 8-9). The antique busts are not so easily identified, although the largest – Jupiter – faced into the Main Hall from the centre of the west gallery (Fig. 4). According to Logan Campbell's original list, the others were Caesar, Juno, Homer, Socrates, Seneca, Ajax, Plato, Augustus, Clytie and Ariadne.

The plaster copies of "the unequalled productions of ancient Greece and Rome" proved an

instant drawcard, and took credit for increased visitor numbers to the Museum. A full year after their arrival, public interest continued "without abatement" (Ann. Rep. 1878-9: 8). They afforded "a real basis for Art education" and granted "a means of rational enjoyment to all lovers of the beautiful". Logan Campbell's intended "School of Design" had materialised as The Free School of Art; it now had 15-20 regular students and continued to enjoy "encouraging" progress (Ann. Rep. 1878-9: 9).

BENEFACTORS AND BEQUESTS

The Council's early aim to establish "a real and solid knowledge of Art in Auckland" (Ann. Rep. 1881-2: 7) was assisted by another local businessman and benefactor, James Tannock Mackelvie, in 1881-2. "Two magnificent paintings" – *The Spirit of Justice* by Daniel Maclise, and a work by "eminent German artist" Baron Tiesenhausen – were the first of several gifts, placed in the Museum until such time as "a building more especially devoted to Art and Antiquity should be erected in Auckland" (Ann. Rep. 1881-2: 7). The Mackelvie collection of paintings and "other art treasures" occupied the north gallery above the Main Hall. Maclise had been described by a contemporary English painter William Powell Frith as "out and away the greatest artist that ever lived" (Chilvers & Osborne 1988: 304). Therefore, thanks to the generosity of Messrs Russell and Mackelvie the Auckland Museum could claim the best of both worlds – ancient and modern. *The Spirit of Justice* was an oil version of a fresco Maclise produced for the House of Lords, and the identity of the other "magnificent" painting received in 1881 was *Fort Keruba, Coast of Esthland, Baltic Sea, Destroyed by the British 1854*, by Baron Paul Freiherr Tiesenhausen. Coincidentally, in 1999 it was on display in what had been the second home of the Auckland Museum, the Northern Club in Princes Street.

When the Auckland City Art Gallery opened in 1888, it relieved the Auckland Museum of the paintings associated with the Mackelvie collections, and three more from another benefactor, Sir George Grey (Ann. Rep. 1883-4: 8). This allowed the installation of new cases on the north gallery in 1891 for the temporary accommodation of a collection of ethnographic material, deposited by Gilbert Mair in 1890 and purchased by the Museum in 1901 (Ann. Rep. 1890-1: 8, 1891-2: 7, 1901-2: 7).

The early 1880s was a period of growth for the natural history displays, commencing with the arrival of a series of alpine birds and animals from Geneva, skeletons of vertebrates from the Royal College of Surgeons, and a collection of rocks from London (Ann. Rep. 1880-1: 8-9). The itinerant Austrian collector, explorer and taxidermist Andreas Reischek was employed on a temporary basis to set up "a large proportion" of the Museum's growing stock of skins (Ann. Rep. 1880-1: 9). Foreign and New Zealand shell displays also benefited at this time from a new table-case along the whole length of the south gallery in the Main Hall, while a collection of humming birds was presented by the appropriately named Dr Finsch (Ann. Rep. 1881-2: 7).

By 1882 there were already problems with the six year old building and its operating budget. Council recognised that one of the "many serious and growing disadvantages" of an inadequate income was the lack of suitable cases and fittings for exhibition and storage. Apart from some recent improvements, "the whole of the fittings require[d] alteration or renovation" (Ann. Rep. 1881-2: 8). Relief arrived some three years later in the form of the Costley bequest, enabling the installation of "excellent cases, of uniform plan" throughout the Museum. This major refurbishment required the closure of the building for a long period, and it reopened with another conversazione, on 21 November 1884 (Ann. Rep. 1884-5: 7). With an eye to the future, the Council applied £2,500 to the purchase of freehold property adjoining the southern boundary of the Museum (Ann. Rep. 1884-5: 5).

Fig. 10. Main Hall of Auckland Museum at Princes Street, showing the small pataka, Te Oha, installed about 1885. The centre of the hall is now occupied by larger table display cases, probably those made possible by the Costley bequest (Ann. Rep. 1884-5: 7). The Venus de Milo can be seen to the right of the pataka front. (Auckland Museum Library, C42385).

The mid-1880s saw sizable additions to the Museum's Maori collection in the form of a pataka (Fig. 10) and war canoe. The former was placed in the entrance hall or Main Hall in the company of "miscellaneous Maori carvings, formerly scattered in various parts of the Museum" (Ann. Rep. 1886-7: 6). For a period it kept the company of skeletons, antique statues, specimen jars and table-cases, in what was described as an "orderly but rather juxtaposed collection" (Powell 1967: 17).

The war canoe, Te Toki a Tapiri, arrived at the Museum in 1885 and was placed in an annexe erected at the south side of the building and renovated "in accordance with old Maori style" (Ann. Rep. 1885-6: 7, 1886-7: 7). The only surviving image of this interim home for the war canoe may be an aerial view of Auckland lithographed in 1886 (Fig. 11). A lean-to structure is seen along the south face of the Museum: at approximately 30.5 m (100 ft.) long it could have provided for the storage and presumably renovation of the 24.5 m (80 ft) vessel.

Significant natural history display developments during the 1880s included the installation of habitat groups of tuatara and kea (Ann. Rep. 1886-7: 6). But the need to enlarge the Museum was becoming increasingly apparent: it was now impossible to classify and arrange the collections. The general appearance of the institution and its educational value suffered from "the fact that the most incongruous objects have of necessity to be exhibited in juxtaposition". Meanwhile,

Fig. 11. Detail of an aerial view of Auckland, compiled and drawn by George Treacy Stevens, and lithographed at the *Evening Star* office, 1886. The Auckland Museum, on the corner of Princes Street and Eden Crescent, is near the centre of the picture. Along the south wall of the Museum is a low structure, probably the annexe erected to accommodate the recently arrived war canoe, Te Toki a Tapiri (Ann. Rep. 1885-6: 7, 1886-7: 7). (Auckland Museum Library, C56636).

the wooden buildings on the corner of Princes Street and Eden Crescent – presumably the caretaker's cottage and what remained of the old Post Office – were leased to the University College (Ann. Rep. 1886-7: 7-8).

In December 1889, after 11 years of operation, Logan Campbell's School of Art closed. It was eclipsed by a similar and well-endowed school (now the University of Auckland Elam School of Fine Art) allowed for by the will of the late Dr Elam (Ann. Rep. 1889-90: 9). Meanwhile, the statues remained in the Main Hall where they would soon be viewed as a bar to progress. Despite the need for enlargement, some progress was still possible inside the Museum. New cases were installed on the floor of the Main Hall for foreign and New Zealand shells, thereby liberating table-cases on the north gallery for New Zealand minerals, ores and rock specimens (Ann. Rep. 1887-8: 7, 1888-9: 8). But by 1891, when the ethnology collection was

rearranged and relabelled and the centre of the Main Hall taken up by a show case of "Bornean Mammals" (Ann. Rep. 1888-9: 7, 1890-1: 7), the enlargement of the Museum could be postponed no longer (Ann. Rep. 1891-2: 6-8).

1892-1896: FIRST ADDITION

On 29 October 1892 the Governor of New Zealand, Lord Glasgow, formally opened Auckland Museum's long-awaited addition (Figs 12-14). The Council went into overdraft to finance the new hall, 100 ft long and 50 ft wide (Ann. Rep. 1891-2: 6), designed by architect Edward Bartley. Built of brick, with a concrete floor and roofed with iron and glass, it was "practically fireproof". It was placed on the south side of the main building, parallel to and set back slightly from Princes Street (Fig. 12). The cost was £1,074 17s 6d which did not include show-cases

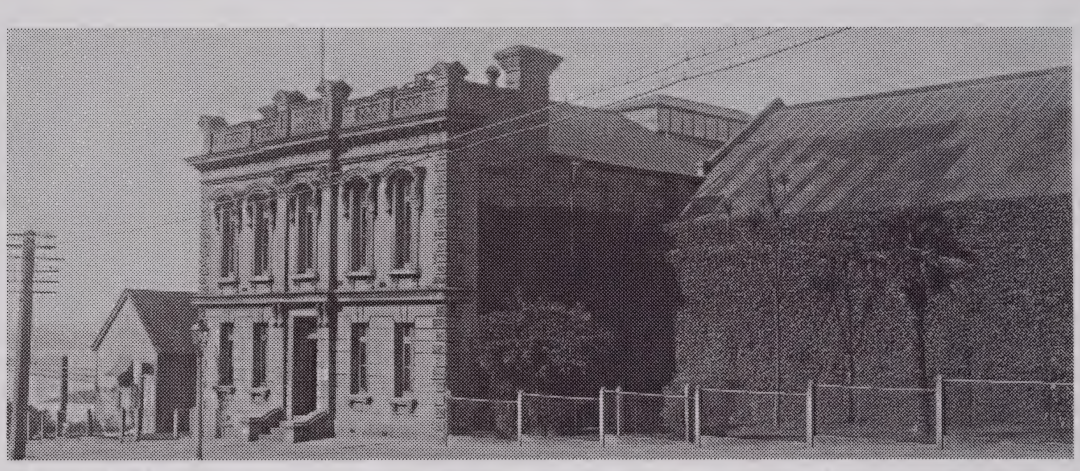

Fig. 12. Auckland Museum in Princes Street, showing the south wing (or Ethnological or Maori Hall) to the right, completed in 1892, and the caretaker's cottage to the left. Photographed 15 August 1917 by H. Winkelmann. (Auckland Museum Library, C23825).

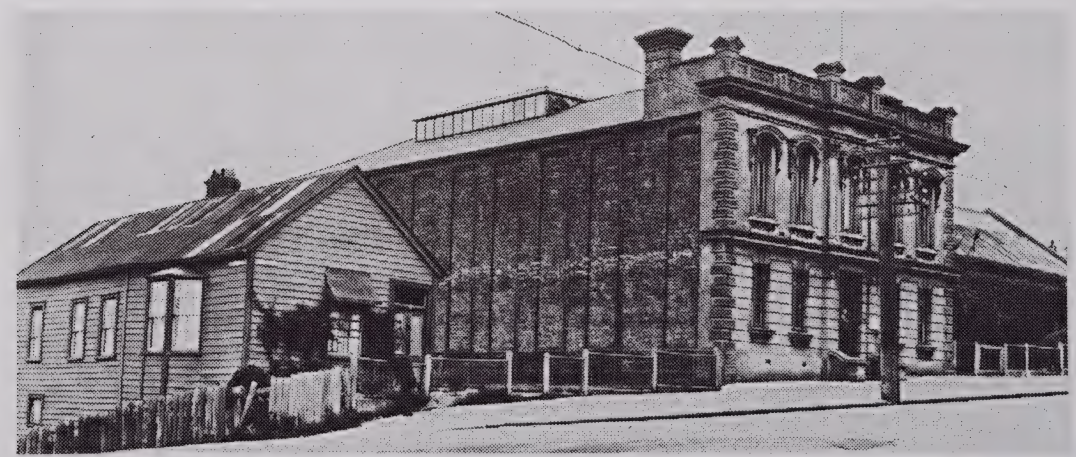

Fig. 13. Auckland Museum in Princes Street, showing the caretaker's cottage to the left, and the south wing (or Ethnological or Maori Hall) to the right. (Auckland Museum Library, C6122).

Fig. 14. Auckland Museum in Princes Street, viewed from the south-east, showing the Ethnological (Maori) Hall (arrowed) added in 1892. (Auckland Museum Library, C56639).

("always an expensive item in Museums"), gas fittings, the renovation of the war canoe, and the erection of the small pataka, Te Oha (Ann. Rep. 1891-2: 8, 1892-3: 7).

The new hall was intended for ethnological collections, particularly those "illustrating the habits and mode of life of the Maori race." Many of the large exhibits which had necessarily been scattered throughout the old building were now brought together. The main building was thereby freed from "a mass of heterogeneous articles" and the Maori collection – "by far the most complete in the colony" – was now "suitably displayed and exhibited" (Fig. 15). To this end, all specimens in show-cases were mounted on suitable stands, positioned for convenient viewing and provided with "a full descriptive printed label" (Ann. Rep. 1892-3: 7-8).

Access to the new Ethnological Hall was through an opening on the southern side of the original building (Fig. 23). From here the visitor faced the right hand side of the small pataka, the prow of the war canoe, and the front of the large pataka, Te Puawai o Te Arawa (Fig. 16). Originally from Maketu, Bay of Plenty, the latter had been dismantled and shipped to Auckland and installed at the south end of the new hall about 1894 (Ann. Rep. 1894-5: 7).

The relocation of the ethnological material had almost immediate benefits for the natural history collections back in the Main Hall. By 1894 the mammals and foreign birds had been "entirely re-arranged" and "considerable progress had been made towards supplying the chief sub-divisions and families with printed descriptive labels, accompanied with maps showing their geographical distribution". Also, a special show-case was set up for the Museum's collection of moa bones (Ann. Rep. 1893-4: 7), while the foreign bird, mineralogical and New Zealand fossil collections were rearranged (Ann. Rep. 1894-5: 8).

In 1895 Auckland Museum is believed to have received one of its most famous visitors, the French artist Paul Gauguin, en route from Sydney to Tahiti. Although no signed visitors' book survives – as in the case of the Auckland Art Gallery – a small number of drawings in Gauguin's "Auckland Sketchbook" indicate that he studied Maori artefacts on display at Princes Street.

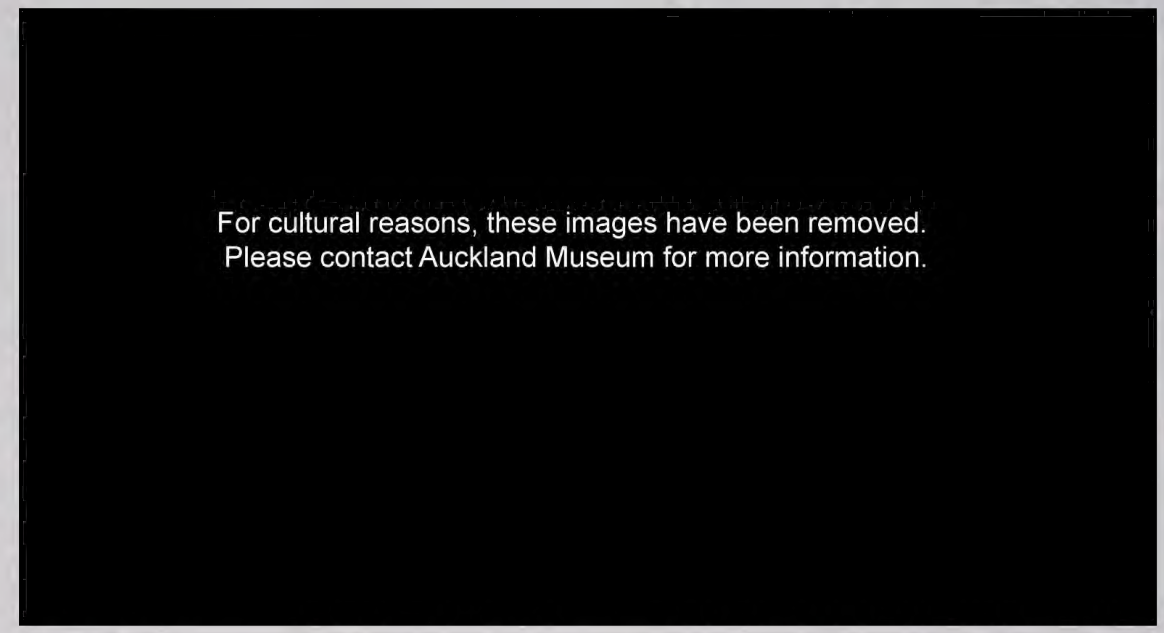

Fig. 15. The war canoe Te Toki a Tapiri along the east wall of the Ethnological or Maori Hall, opened in 1892. This view is before the addition of the Statue Hall (to the south-east wall) in 1897. At the stern of the canoe is the large carved figure of Pukaki, in the Auckland Museum collection since 1877. (Auckland Museum Library, 4693).

Fig. 16. View towards the south-east corner of the 1892 Ethnological Hall. The large pataka, Te Puawai o Te Arawa, was installed in 1894, while the smaller Te Oha has been relocated from the Main Hall. (Auckland Museum Library, B393).

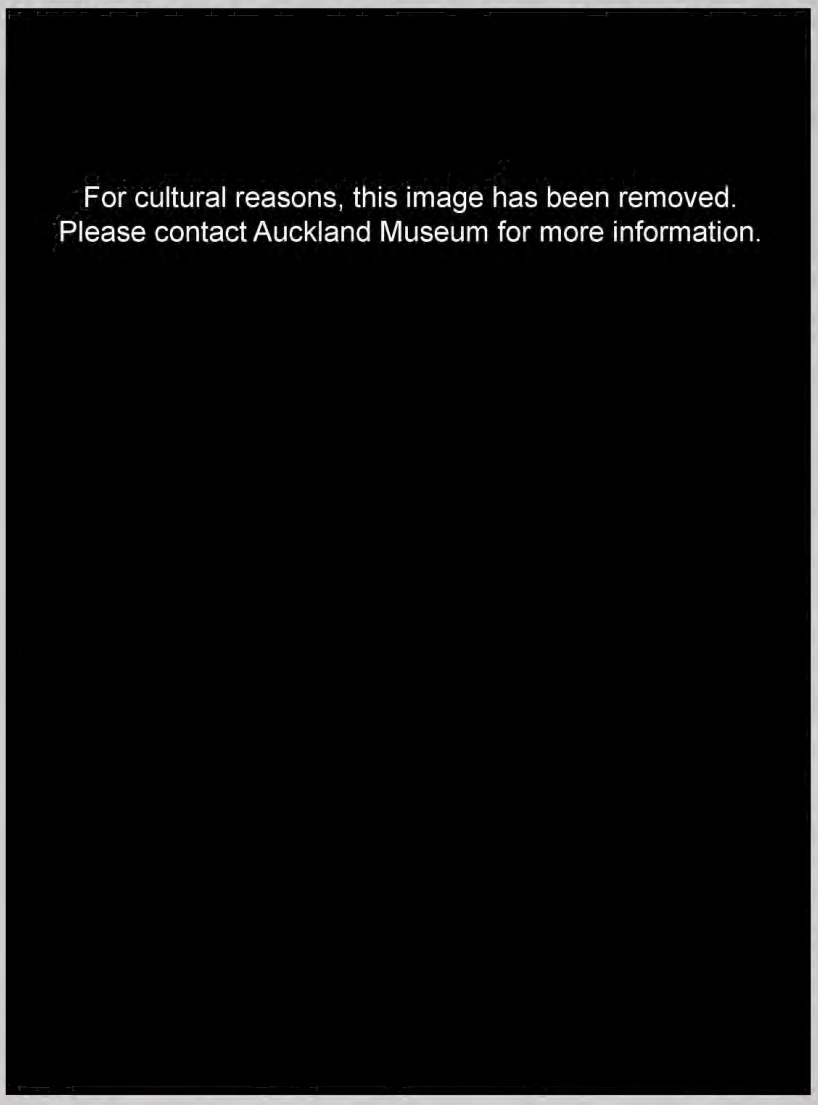

Fig. 17. The "incongruous appearance" of the Auckland Museum as seen by the *New Zealand Observer and Free Lance* (6 January 1894), showing a now rare student of the antique, and a giraffe skeleton mistaken for a moa.

Clearly identifiable among these is the collection of carved boxes and bowls then recently donated to the Museum by Gilbert Mair. Gauguin's sketchbook includes a drawing of an unidentified Maori carved face, the reclining sternpost figure on Te Toki a Tapiri, and what may be the lower legs of the giraffe skeleton then standing in the Main Hall (Nicholson 1995). At the time of Gauguin's visit it seems likely that the Mair collection had been transferred from its previous location, on the north gallery above the Main Hall to the recently opened Ethnological or Maori Hall (Ann. Rep. 1892-3: 7-8).

In 1897 the Council once again reflected on the perennial problem of space. The centre of the Main Hall still contained antique statuary, but this "admirable" collection was now considered

out of place, "surrounded by stuffed birds and animals". Its use by art students had become greatly limited, and its location now thwarted the "extension and proper arrangement of the natural history department". The solution to the "incongruous appearance" of the hall was to move the statue collection, and so Mr. Bartley's services were sought once again (Ann. Rep. 1896-7: 7). Meanwhile, the crowded state of the Museum and the waning popularity of antique statuary provided inspiration for a local cartoonist (Fig. 17).

1897-1904: THE STATUE HALL

On 19 October 1897 Auckland Museum opened the second extension to its original Princes Street building. The new hall was 50 ft (15.2 m) square and adjoined the eastern side of the Ethnological Hall, to which it was connected by an archway (Figs 18, 19). It was of brick, with concrete floor and iron and glass roof (Ann. Rep. 1897-8: 7) and the walls were treated in a "deep Pompeian red, forming a very effective background for the statues." (Fig. 20). The latter were now "well placed and well lighted" and each supplied with a printed label "for the convenience of visitors" (Ann. Rep. 1897-8: 7, 1898-9: 8). The installation of a moveable platform and "other necessary conveniences" allowed for the new hall's additional function, the accommodation of Institute meetings too large for the present lecture room, presumably the Library in the main building (Ann. Rep. 1896-7: 7).

With the transfer of the statues to the new hall the Council was able to plan a long-term

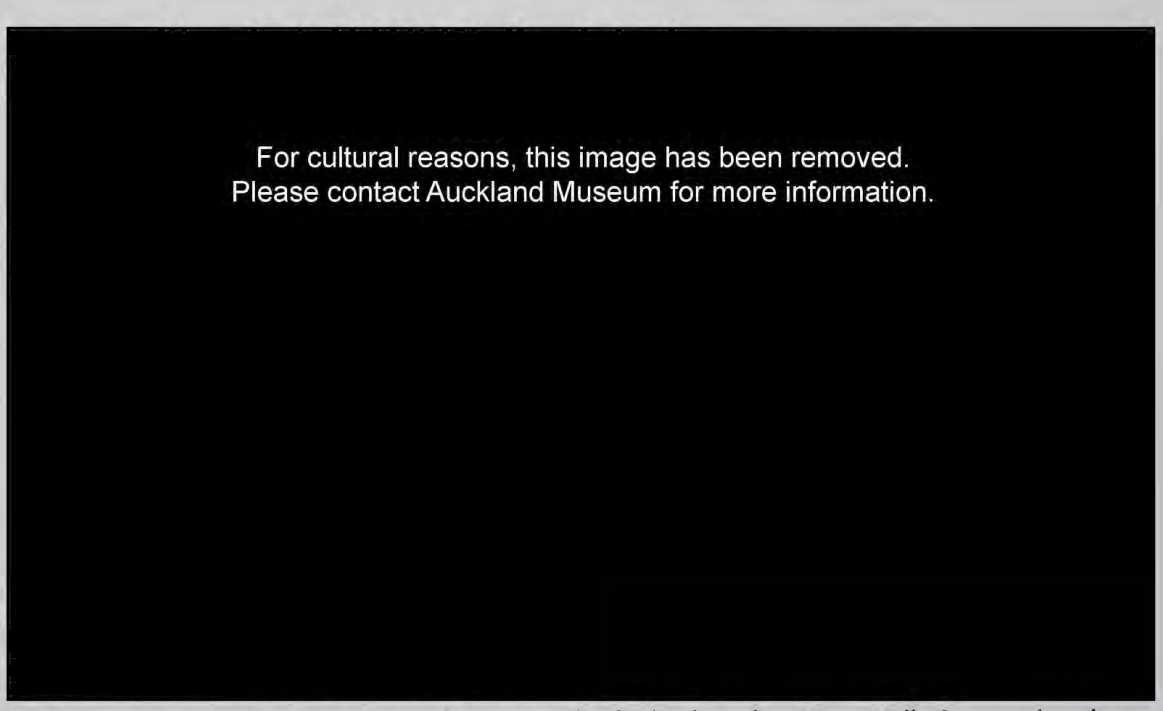

Fig. 18. War canoe Te Toki a Tapiri along east wall of Ethnological or Maori Hall. Compared to the earlier view (Fig. 15), this shows the arched entrance to the Statue Hall which opened in 1897 and necessitated the removal of a section of display cases along the east wall. This photograph predates the installation of the meeting house Rangitihi, in 1905. The Pukeroa gateway is displayed near the stern of the canoe. (Auckland Museum Library, Josiah Martin 4693).

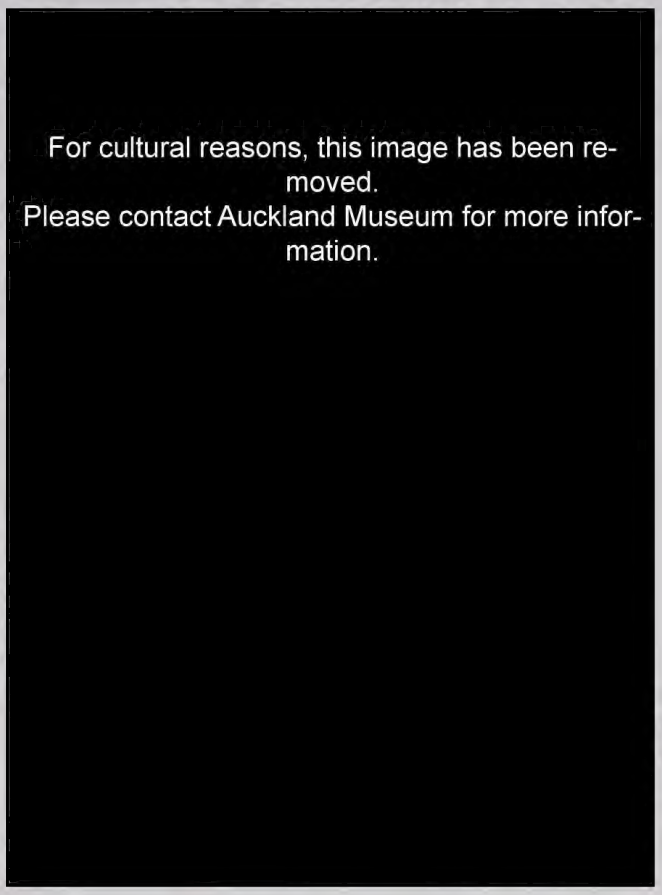

Fig. 19. Large carved figure from Tolaga Bay (accessioned in 1899) displayed at entrance to Statue Hall, off Maori Hall. To the left is the reclining figure of Theseus. (Auckland Museum Library, B655).

Fig. 20. The interior of the Statue Hall, completed in 1897. The statues are (from left): Dying Gladiator, Apollo Belvedere, bust of Jupiter, Venus de Milo, bust, Discobolus, bust, Laocoon, bust, and Dancing Faun. From photocopy of photograph, present location unknown.

project; the positioning of groups of larger animals in new cases in the Main Hall. Elsewhere in the building, mineral displays were installed in a set of ten wall-cases on the south side of the gallery and the whole of the Maori collection was "re-arranged and re-numbered" (Ann. Rep. 1898-9: 8-9). Later, it was the turn of the shells and New Zealand birds to be refurbished (Ann. Rep. 1900-1: 7-8), and the purchase of the Mair Collection prompted a further rearrangement of "the whole Maori Collection" (Ann. Rep. 1901-2: 7, 1902-3: 7).

Further to the few surviving photographs, understanding the layout of the Museum's displays at the end of the 19th century is assisted by an entry in the *Cyclopedia of New Zealand* (Anon. 1902). The Maori collection was described as unrivalled in the Colony, and particular mention was made of the carved boxes and bowls, these exceeding all other examples of Maori carving for their "originality of design and fineness of execution". These were probably the bowls observed by Gauguin, and located on the east wall adjacent to the prow of the war canoe.

The *Cyclopedia* records that the ground floor of the Main Hall was home to a large case of apes and monkeys, and desk cases of shells, both local and foreign. Mammals were found in wall cases on the south side, with over 600 species of foreign birds on the north side and east end. Up on the gallery, a very complete collection of New Zealand birds was found on the north side, a case of moa and other extinct New Zealand birds on the west, with fish at the east. Rocks and fossils filled wall cases to the south, and desk cases of minerals surrounded the whole gallery.

1905-1929: GROWING CONGESTION

RANGITIHI

In 1901 the Council purchased the carved Maori house Rangitihi, which originally stood at Taheke on the northern shores of Lake Rotoiti (Ann. Rep. 1901-2: 8). Plans were announced for the only possible location for the house – 60 ft (18.3 m) long by 25 ft (7.6 m) wide – in a 50 ft (15.2 m) by 50 ft square annexe to be erected on the eastern side of the Maori Hall, occupying the vacant space between the Statue and Main Halls (Ann. Rep. 1903-4: 7). The estimated cost was considerable and the matter was put to a sub-committee. Two years later an application for a government subsidy was successful, and building could commence (Ann. Rep. 1903-4: 7). After a series of financial and other complications – including the destruction by fire of the reed-work panels being prepared at Rotorua (Ann. Rep. 1905-6: 7) – the house was opened for viewing in the completed hall (Fig. 21).

This development also had implications for existing displays, necessitating the dismantling of a large portion of the glass showcases on the east side of the Maori Hall, primarily to provide access to the new hall. This led to yet another total rearrangement, and also required the removal of almost all the foreign anthropological collections (Ann. Rep. 1904-5: 8). The plan was to exhibit the latter in the half of the extension not occupied by Rangitihi (Ann. Rep. 1904-5: 7), and so by 1906 a selection of Polynesian ethnographic material went on display in this new space (Ann. Rep. 1905-6: 8). With the installation of Rangitihi now complete the Museum could claim "the most perfect example of its kind attached to any Museum". Further, it was "the one in which most care has been taken to preserve a strict agreement with Maori style" (Ann. Rep. 1906-7: 8).

Because of its length, the porch of Rangitihi extended some 10 ft (3 m) beyond its purpose built gallery. It faced west into the Maori Hall – towards the starboard prow of the war canoe. Large carved structures now sat on three sides of the hall.

Fig. 21. The meeting house Rangitihi, installed in the Maori Hall in 1905. The large carved figure of Pukaki is now located (see earlier position in Fig. 15) near the entrance to what was originally the Statue Hall, and after 1917 housed the Grey Collection (Ann. Rep. 1916-7: 9). (Auckland Museum Library, 17508).

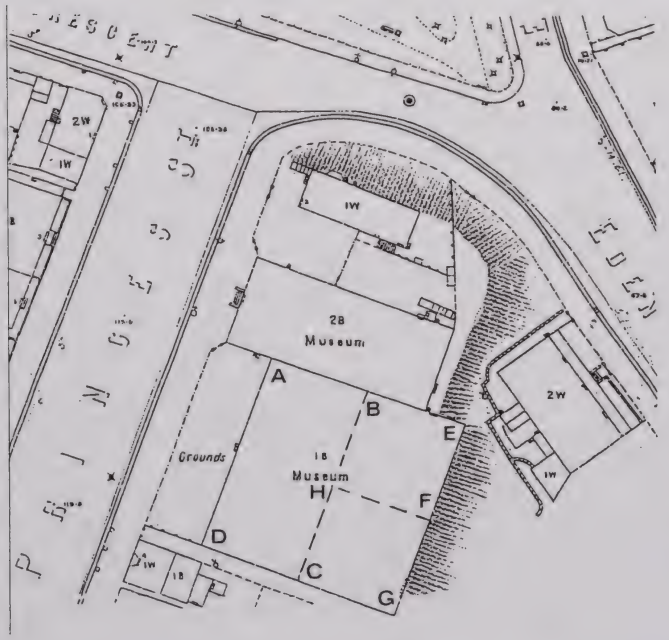

Fig. 22. The full extent of the Auckland Museum building in Princes Street, as indicated on the 1908 Auckland Gas Company plan. The 1892 Ethnological or Maori Hall is shown as ABCD, the 1897 Statue Hall as HFGC, and the 1905 extension to accommodate Rangitihi and (initially) Polynesian ethnographic material as BEFH. (Auckland Museum Library, C56635).

With the completion of the infill gallery for Rangitihi and, subsequently, Polynesian ethnography and (in 1916) minerals, the Auckland Museum at Princes Street had reached its maximum size (Fig. 22). It had now been extended significantly on three occasions, and grown more than three-fold in size to some 14,500 ft^2 (1350 m^2).

A HALL FOR MAMMALS

By 1905 the eight year old plan to devote the Main Hall to displays of larger mammals was about to be realised (Ann. Rep. 1898-9: 8). The first of the intended groups – a pair of lions with four cubs – had arrived (Ann. Rep. 1904-5: 8), followed by a pair of tigers and a leopard (Ann. Rep. 1905-6: 7). A polar bear and three musk oxen followed, forming "a very attractive addition" to the centre of the hall (Ann. Rep. 1906-7: 9), and a group of South African animals later occupied the eastern end (Ann. Rep. 1907-8: 8). In addition, the foreign vertebrates in the Main Hall were thoroughly overhauled, and the Museum received a large plate-glass showcase containing 35 birds and mammals, mainly from Canada (Ann. Rep. 1905-6: 8). There were also developments upstairs: shelving and wire guards were installed between the pillars on the gallery for the safety of the alcoholic specimens (Ann. Rep. 1906-7: 9). The latter were shortly to be joined by foreign shells, previously displayed on the ground floor of the Main Hall (Ann. Rep. 1908-9: 7).

Despite the recent extensions, other departments of the Museum were desperately short of space. There was concern that the need for "transverse presses" (double-sided shelving) in the Library would prevent the use of that room for meetings of the Institute (Ann. Rep. 1904-5: 9). Another function for the Library became apparent some two decades later when the south-west corner was taken over for mosquito research, under the direction of Gilbert Archey (Powell 1967: Fig. 21).

At least a "properly equipped workroom", which had been planned for a few years previously was now under construction (Ann. Rep. 1904-5: 7, 1907-8: 7). Measuring 50 ft (15.2 m) by 30 ft (9.1 m), it was "very conveniently placed" in the basement beneath Rangitihi (Ann. Rep. 1908-9: 7, Gill 2000: fig. 3). Photographs in the Princes Street Album show the multiple uses of this spaces, filled with cupboards, crates and specimens. This record does not include one of the Museum's largest and most significant artefacts, the goddess figure Kave, from Nukuoro, Caroline Islands. This "wooden idol" was accessioned in 1878 but apparently remained hidden from public gaze until its inclusion in a special exhibition in 1962 (Wolfe 1993).

There may have already been a basement space in the original 1876 building. Photographs of the antique statues in the north-east corner show a newel post and possible balustrade, suggesting a staircase (Fig. 6), and exterior views of the eastern end of the Museum indicate the potential for basement development on the sloping site (Fig. 27). Nevertheless, by 1917 the workroom beneath Rangitihi was considered "badly lighted and insufficiently ventilated, and so damp that, with the exception of minerals, no specimens can be stored therein without grave risk of injury" (Cheeseman 1917: 4).

In a burst of housekeeping in 1909-10, all the birds and mammals – both New Zealand and foreign – were "thoroughly cleaned and renovated, and remounted in a more modern style" (Ann. Rep. 1909-10: 8). By now the Museum had appointed its own taxidermist, or "preparator of specimens", Mr. L.T. Griffin. One of his first duties was maintenance of the Statue Hall (Ann. Rep. 1908-9: 8). The plaster casts were distempered, the walls retinted and a barrier erected to keep the statues out of reach of the public (Ann. Rep. 1909-10: 8). Shortly afterwards Griffin completed 68 "carefully mounted and painted from life" New Zealand food-fishes, and casts of the tuatara and other New Zealand reptiles (Ann. Rep. 1910-11: 7).

The Auckland Museum began the second decade of the century on a positive note. In the 1911-12 year it received 79,059 visitors, an increase of 3,705 for the previous year (Ann. Rep. 1911-12: 7). As was then the practice, the Museum was open from 10 am to 5 pm on weekdays, from 2 pm to 5 pm on Sundays, and closed for 10 days during the year for "the usual annual cleaning and re-arrangement".

This period also saw some major additions to the collection, including the "large and beautiful" Dadley collection of Japanese articles, and the figure-head of HMS *Virago*, presented by the Admiralty (Ann. Rep. 1911-12: 8). But the most important new accession was undoubtedly the series of "ancient historic carvings from the East Coast district", once part of a pataka erected at Te Kaha about 1780 (Ann. Rep. 1911-12: 9). In 1900 these carvings were obtained from the Maori owners by Mr Spencer, and later purchased by the Museum. Carved before the introduction of iron tools, these were "remarkably good examples of the best period of Maori workmanship", and were "probably unequalled in the Dominion". They were displayed at the north end of the Maori Hall (Fig. 23).

Because the purchase price of the Te Kaha carvings – £425 – was beyond the Museum's means, it decided to appeal to the citizens of Auckland for assistance. Taking advantage of this opportunity, it sought additional funds – £700 in total – to cover another major initiative, a planned display of flightless birds which included a restoration of a moa (Ann. Rep. 1911-12: 9). In the event, £681 was subscribed, which enabled the Museum's preparator of specimens, Mr Griffin, to proceed with these projects (Ann. Rep. 1912-3: 6). His skills were appreciated

Fig. 23. View towards Main Hall at north end of Maori Hall. The Te Kaha carvings, which came into the Museum in 1911, are displayed at the north end of the Hall, and on the extreme right is the entrance to the 1905 addition. (Auckland Museum Library, B10993).

by 550 visitors to a conversazione, on 8 October 1913, when the main attraction was a display of flightless birds and restoration of the largest species of moa, in the centre of the Main Hall. Such was the public's fascination for these subjects that the Museum recorded its greatest attendance for one day – 1,329 – on Sunday 12 October. Further ornithological progress included a group of birds of paradise, "an unusually handsome and attractive exhibit" (Ann. Rep. 1912-3: 8-9). Also, new habitats illustrated the common shag, spotted shag and the North Island kiwi (Ann. Rep. 1912-3: 8, 1914-5: 8, 1915-6: 10), with backgrounds to all three displays painted by Kennett Watkins.

By 1912 the Museum was running out of room again. To provide for new acquisitions "large numbers of specimens" had to be withdrawn from exhibition and packed away. The collection of New Zealand food-fishes, for example, had been shown at the expense of "hundreds of rocks and minerals" (Ann. Rep. 1911-2: 10). The Museum desperately needed "an enlargement of no small size" (Ann. Rep. 1912-3: 11) and in every department "no improvement of note [could] be made until more room is available". In particular this situation affected the "appearance and usefulness" of the Maori collection (Ann. Rep. 1913-4: 12), and improvements began with new displays on fishing and greenstone (Ann. Rep. 1914-5: 10).

A rather different perspective is provided by *The Auckland Guide* of 1913. Auckland Museum was the first mentioned of the city's public buildings and institutions, and although it could boast "no proud architecture" it was "the humble home of Maori treasures ... not equalled in the world". In this "sanctuary", both antiquarian and layman could "find the answer to much that would otherwise be unsolvable". Pandering to current notions of Maori culture, the guide described "old-time" and "racial relics" that illustrated the development of Maori art "down the dim centuries of primevalism". In addition the Museum's "conchological and piscatorial" exhibits were singled out, as was its recently unveiled reconstruction of a moa.

Something of a peer review on the state of Auckland Museum was published in 1913 by the Director of the Bernice Pauahi Bishop Museum, Honolulu (Brigham 1913). During an eight month "Journey Around the World to Study Matters Relating to Museums", William T. Brigham inspected several such institutions in New Zealand. Of Auckland's he reported that the "whole arrangement" had improved since his previous visit, 25 years earlier. It was, he claimed, "hard to get enough" of this one, and after his final visit he retired with Thomas Cheeseman to the nearby Northern Club for lunch. Brigham's report includes two views of the Museum's "canoe hall"; one showing an unbroken line of display cases down the east wall of the Maori Hall and therefore predating the installation of Rangitihi (c. 1905), and the other showing the war canoe angled to accommodate the now installed and protruding house. This pair of photographs confirms the many changes within the Museum during this period, and the remarkably nomadic nature of certain Maori carvings.

THE GREY COLLECTION

In 1914 the Statue Hall was seen as a temporary solution to the Museum's ongoing shortage of space. The recent growth of its Maori section had suggested the Museum as logical home for all ethnographic collections in the city, in particular the George Grey Collection of "Maori antiquities and foreign ethnological articles" in the Art Gallery (Ann. Rep. 1916-7: 9). Thus the decision was made to transfer the latter to Princes Street, to replace the Russell Collection in the Statue Hall. An agreement with the City Council required the Maori items in the Grey Collection to be displayed separately from the Museum's own Maori material. The presentation of both collections – many of which had not been previously exhibited – needed new cases and fittings, and opened to the public on 17 April 1917 (Ann. Rep. 1916-7: 9, Figs 24-26). But it

Fig. 24. The carved figure of Pukaki stands at the entrance to the 1905 addition to the Maori Hall. Previously known as the Statue Hall, in 1917 this gallery became the new home for the Grey Collection. (Auckland Museum Library, 14813).

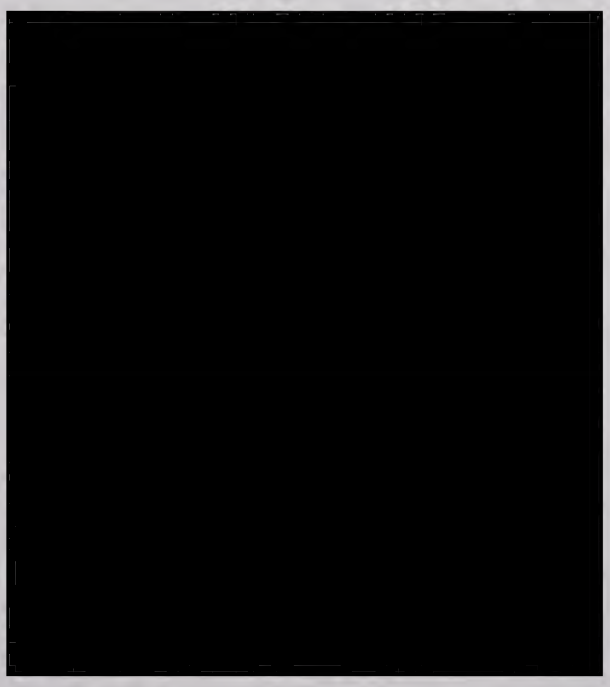

Fig. 25. Opposite view to Fig. 24, looking west into the Maori Hall from the Grey Collection gallery. This views shows sections of the large pataka Te Puawai o Te Arawa and the war canoe. (Auckland Museum Library, C56629).

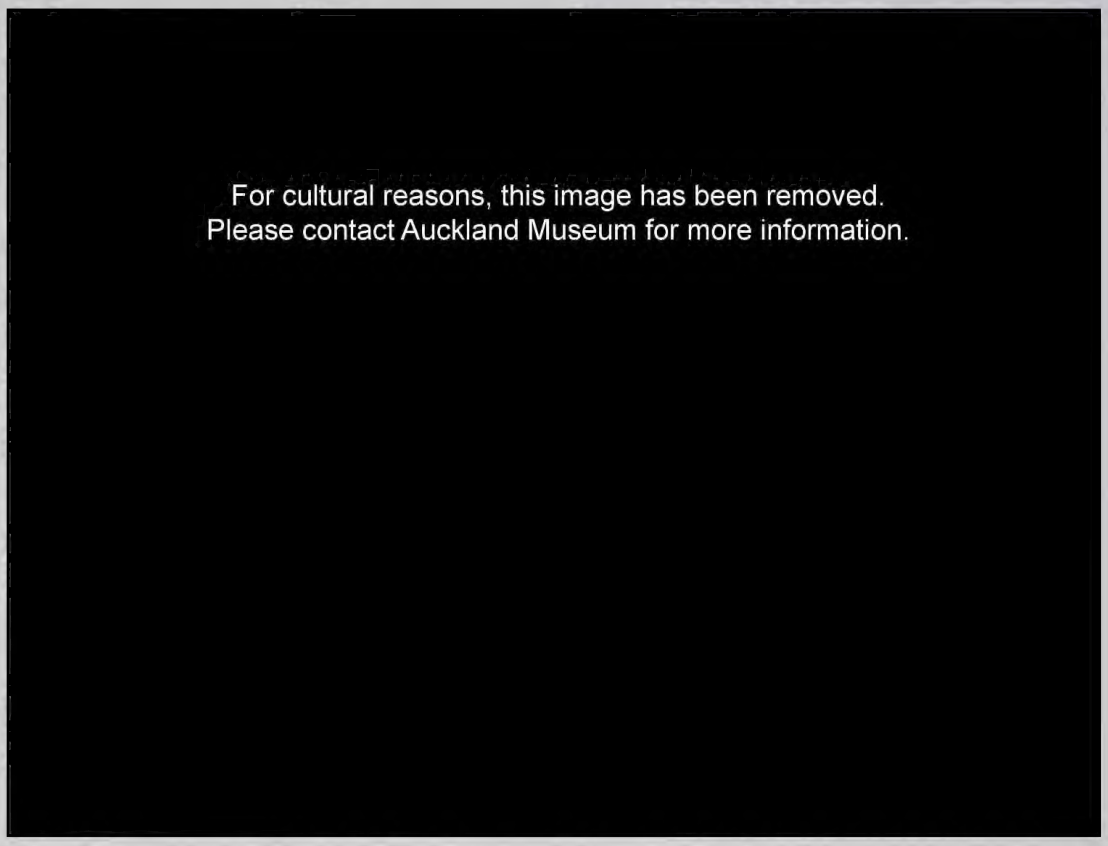

Fig. 26. Panoramas of the south (upper) and north (lower) walls of the Grey Collection Gallery. A section of the large pataka Te Puawai o Te Arawa is visible through the entrance on the west wall (lower left). (Auckland Museum Library, top (from left): C56632 & C56633, bottom (from left): C56631 & 13313).

was several months before "the minor details of the labelling etc. were completed" (Ann. Rep. 1915-6: 8, 1916-7: 9).

Within the 1905 extension there was a space beside Rangitihi, approximately 50 ft (15.2 m) long by 25 ft (7.6 m) wide. Previously this held a portion of the foreign ethnography collection, and was now converted into a mineral room, opening on 4 December 1916 (Ann. Rep. 1916-7: 9). This enabled the gallery of the Main Hall to be reserved entirely for "representatives of the New Zealand fauna – birds, fishes, reptiles, shells and other invertebrata" (Ann. Rep. 1915-6: 8). To this end, the table-cases on the south side of the gallery were ear-marked for New Zealand shells (Ann. Rep. 1917-8: 8).

The arrangement between the Auckland Institute and Museum Trust Board and the City of Auckland concerning the Grey and Russell Collections had first been suggested to the Council (of the Institute) on 22 February 1893 by John Logan Campbell (Logan Campbell correspondence, Museum Archives). He, and 40 appended signatories, felt the statues were out of place in the Museum and that the Art Gallery was "a more fitting repository". The same gentlemen also wrote to the City Council suggesting that the Grey Collection was inadequately housed in the latter institution (Logan Campbell correspondence, Museum Archives). Twenty-

two years later, on 2 December 1915, an agreement was reached. A schedule of "Maori Articles and Other Specimens" constituting the Grey Collection listed 507 items, ranging from the carved front of a pataka to two slabs of moa footprints (Grey Collection file, Museum). In exchange, a second schedule listed the Russell Collection as 20 statues. Apollino and Demosthenes from the original list were now absent, the former having been knocked over and smashed beyond repair by children (*New Zealand Herald* 11 Nov. 2000: A23). Numerically speaking there was still a full complement of 11 busts, although the original Ariadne had been renamed – or replaced by – "Barbarian" (Logan Campbell correspondence, Museum Archives).

The period 1915-1918 saw some particularly large additions to the collection, most notably the 21 ft (6.4 m) carved gateway from Lake Okataina (Ann. Rep. 1915-6: 9) and three full-size Pacific canoes (Ann. Rep. 1916-7: 11, 1917-8: 9). Also, a larger part of the Maori Hall was rearranged, with new cases for weapons, musical instruments and smaller "stone and bone articles" (Ann. Rep. 1917-8: 8) while the larger carvings on the eastern wall of the Hall were redisplayed on a framework erected above the existing cases. Similar improvements also were planned for the opposite side of the Hall (Ann. Rep. 1918-9: 8).

By 1917 the Museum was operating under extreme difficulties. Apart from a shortage of exhibition space, it lacked room for students, storage for duplicate specimens, and had no "retiring rooms" for visitors to provide "an opportunity of consuming a hasty lunch". Council recognised "the limitations and deficiencies of the present site to accommodate a block of buildings commensurate with the importance of Auckland" (Ann. Rep. 1916-7: 13). The existing buildings occupied almost two-thirds of the Princes Street site, and the remaining undeveloped one-third provided little hope for the future. Investigation had shown that its precipitous slope

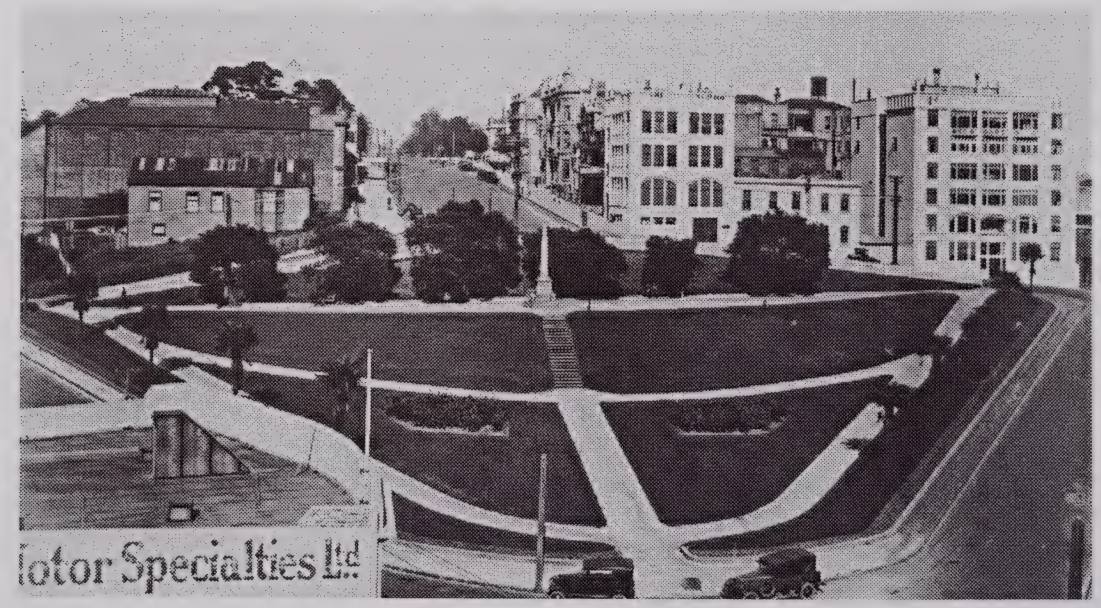

Fig. 27. Auckland Museum (at top left) in Princes Street, photographed from Emily Place, May 1927. This view shows the caretaker's cottage, the north wall of the 1905 addition to the Maori Hall extending behind the Main Hall, and the steep slope which deterred further development of this site. Photo: H. Winkelmann. (Auckland Museum Library, C20042).

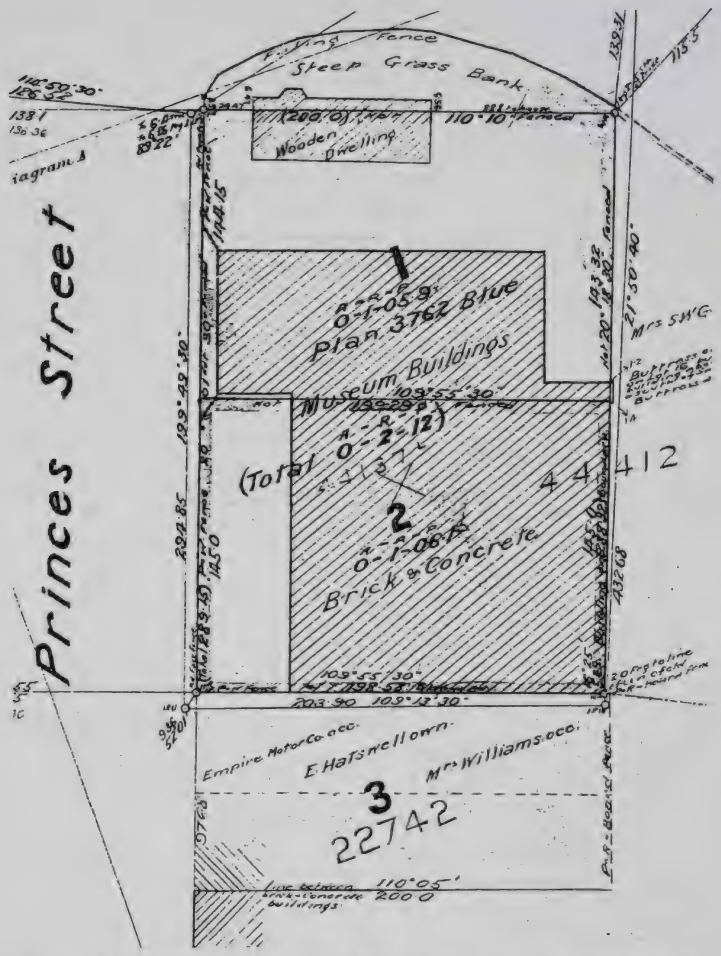

Fig. 28. Plan of Auckland Museum premises in Princes Street, being allotments 1 and 2, section 7, City of Auckland, as surveyed in July 1919. This document was signed by T. R. Peacock, Chairman of Trust Board, 23/7/1919. (Land Information New Zealand, Auckland).

would necessitate "costly and useless foundations" (Fig. 27). A further drawback was the potential for fire; the Museum could not be isolated from other buildings, and a garage – the Empire Motor Co. – now adjoined the Maori Hall (Fig. 28). In Mr Cheeseman's opinion the solution was simple: "the present site must either be abandoned, or at least doubled in size" (Cheeseman 1917: 4-5). By 1918 the Council was looking beyond Princes Street, to Observation Hill in the Domain (Ann. Rep. 1917-8: 12).

In 1922 the Museum reported the arrival of a "first rank" addition to the collection, already described as the "now celebrated Kaitaia Lintel." The official account of this important accession is worth repeating in its entirety:

"Evidently of ancient date, and found in a district bearing incontestable signs of former aboriginal occupancy, [the Kaitaia Lintel] nevertheless differs from all ancient Maori carving. It gives an impression of Melanesian origin, but no carving of similar character is known from

Melanesia. As most authorities consider that it is of pre-Maori age, the best view to take of its history is that it is a relic of the ancient Maruiwi, a race long antecedent to the present Maori. But much enquiry and many comparisons are required before a tenable theory can be offered to explain its origin, and give a clue to the history of the people who made it. It can safely be said that no wooden carving has been found in New Zealand that offers so many problems for discussion. The Council have pleasure in stating that they have been able to purchase the carving, which is now the property of the Museum" (Ann. Rep. 1921-2: 8).

A year later the annual report referred to the "now famous Kaitaia lintel" (Ann. Rep. 1922-3: 8), which would later be a central feature of the Maori gallery in the War Memorial Museum. But there are no photographs of it at Princes Street, although a newspaper advertisement confirms it was on public display. Appropriately, perhaps, the image of the lintel was (mis)appropriated to highlight the attractions of the "Winterless North." According to this imaginative advertisement: "The relic, which is now to be seen at the Auckland Museum, is probably of Mongolian origin, and supports the theory that New Zealand was at one time connected by land with Asia" (*New Zealand Observer Christmas Annual*, 3 December 1921: 41).

While receiving some remarkable additions to its collections, Auckland Museum was accordingly becoming even more congested. There was now "no department ... that [had] sufficient room for exhibition purposes (Ann. Rep. 1922-1923: 9). And to add to the problems, there were now "several leakages in the roof" (Ann. Rep. 1923-4).

PLANNING FOR THE FUTURE

The decision to combine the new museum with a war memorial was made in 1920, and a public appeal for funds met with a ready response. An architectural competition was held in 1922 and the contract for construction was let in July 1924 (Powell 1967: 24). The Princes Street site and buildings went to auction on 31 July 1925, and realised the "satisfactory" figure of £32,000 (Ann. Rep. 1925-6: 9). It was decided that this amount would be spent on showcases and fittings on the new building, and a tender was let to A.E. Edmonds & Co. Ltd. of Birmingham for £21,964/6/1, plus freight, duty and other transport charges (Ann. Rep. 1927-8: 9). The first consignment of showcases arrived on April 1928, with Edmonds sending out two foremen to oversee installation (Ann. Rep. 1928-9: 7).

In mid-1924 preparations for the move from Princes Street began with the closure of the geology room (Ann. Rep. 1925-6: 9) and by 1928, with the exception of the war canoe and certain other large objects, the ethnology collection had been packed up (Fig. 27). Wall cases were dismantled and divided into sections to be recycled as storage units in the new building (Ann. Rep. 1927-8: 9), and transfer of the contents from the old museum was completed in August 1929 (Ann. Rep. 1928-9: 7) (Fig. 29).

Not all of the many collections transferred to the new museum came directly from Princes Street. A member of the public noted that the "numerous casts of Greek and Roman statuary" and – allegedly – the "Maori and other relics from the Grey Collection" had come from the Auckland City Art Gallery (Letter, *New Zealand Herald*, 30/12/29, Museum Scrapbook). The most recent record of the Russell Bequest may date from 1914, the time of its removal from Princes Street, and it is not known how many statues made the journey to the War Memorial Museum in 1929. The plaster casts of Theseus and Ilissus, which once flanked the entrance to the Main Hall in Princes Street, became casualties at some stage. The original sculptures, from the Parthenon, remain in the British Museum. According to their present labels, the statue once recognised in Princes Street as Theseus, may be either Herakles or Dionysos, while the other is thought to represent one of the streams of Attica, either the Cephasus or – as he was known in Auckland – Ilissus.

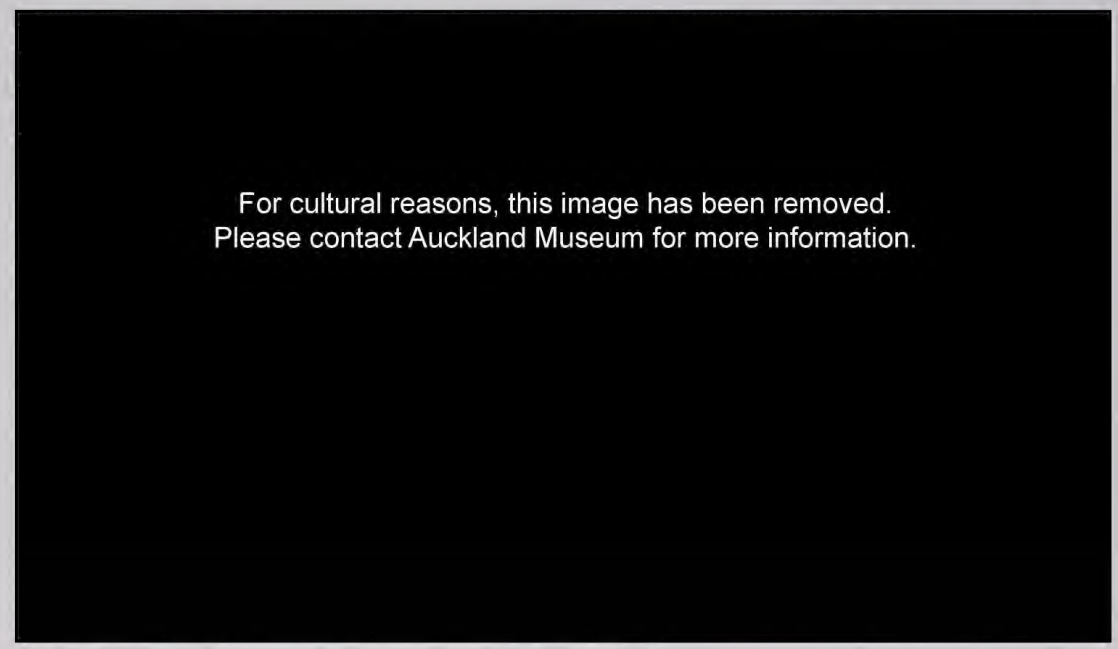

Fig. 29. War canoe Te Toki a Tapiri backed into what was the Grey Collection gallery on the first stage of the move to its new home in the War Memorial building in the Domain, July 1928. The exposed brickwork to the left indicates the earlier location of the meeting house Rangitihi. (Auckland Museum Library, 14812).

Thomas Cheeseman was described as "another admirable instance of how greatly the value of a museum depends on the energy of its curator" (Bather 1895: 208-211). It was through his vision that the Auckland War Memorial Museum opened to the public on 29 November 1929. But with his unexpected death in 1923 he did not see the realisation of his dream. The following year, Gilbert Archey, Assistant Curator of the Canterbury Museum, took over as Curator of the Auckland Museum.

In a little over 50 years since moving into its first purpose-built premises in Princes Street the Auckland Museum had experienced many changes. It was now about to begin the process all over again, in its new home in the Domain.

Acknowledgements: This project evolved from research carried out for the exhibition "Nga Tohu Whakairo: The Art that Inspired Paul Gauguin", held at Auckland Museum in 1995 to mark the centennial of the French artist's visit to Auckland. For assistance with that event I thank Christopher Johnston, and I also acknowledge the help and advice given by Graham (E.G.) Turbott, Brian Gill, Nigel Prickett, Roger Neich and Gordon Maitland.

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DESCRIPTION AND CONSERVATION OF A PROBABLE MOA'S EGG (AVES: DINORNITHIFORMES)

B.J. GILL AND S. COOPER

Abstract. A large, undocumented fossil egg in the Auckland Museum collection was associated with sediment that was probably from the eastern South Island, New Zealand. It is presumed to be a moa's egg (Dinornithiformes), one of only 19 intact enough for measurement of length and width. With external dimensions of approximately 208 x 134 mm the egg would have belonged to one of the medium- to large-sized species of moas. It is a thick-shelled egg (shell at least 1.5 mm thick) with slit-like pores on the outer surface. The conservation treatment involved removing most of the compacted sediment from inside the egg to reduce the risk of damage from excessive weight, and to expose embedded eggshell fragments.

KEYWORDS: Bird; ratite; Dinornithiformes; eggshell; New Zealand; conservation treatment.

INTRODUCTION

The bird collection at Auckland Museum, New Zealand, contains a large oval-shaped egg, registered B4016 (Figs 1-3). It is shattered into large fragments, with a large section collapsed, but the fragments are held together by fine-grained sediment inside the egg. This egg was present in the collection, unregistered and undocumented, when BJG joined the staff of the museum in 1982. It presumably belonged to one of the species of moas (Order Dinornithiformes), the large extinct ratite birds of New Zealand.

Scattered moa eggshell fragments are common fossils in New Zealand, but whole eggs are exceedingly rare and we decided to assess B4016 for conservation treatment. Only 18 other whole or substantially intact moa eggs are known (see table 1 of Gill 2000).

Sediment had been removed from much of the outer surface of the egg before 1982, exposing most of the shell (Fig. 1), but the interior remained filled with sediment, from the surface of which some shell fragments protruded. An unknown consolidant appeared to have been applied (before 1982) to most of the exposed surface of the sediment. The sediment was likely to be obscuring fragments that had collapsed into the egg. It also made the object too heavy for its fragility and therefore prone to breakage. Removal of sediment therefore seemed desirable, to uncover any hidden fragments, lighten the egg, and make it more interesting for display.

METHODS

In 1987 a small sample of sediment was sent to the New Zealand Geological Survey for petrographic analysis. In 2000 the egg was subjected to C.T. scanning at the Mercy Hospital, Auckland, to discover what lay buried in the sediment filling the egg's interior. The egg was scanned in slices 8 mm apart to generate two series of images showing the egg in sagittal and

Fig. 1. Presumed moa egg (B4016), blunter end to left, showing the less weathered "lower" surface. Before the present study, sediment had already been cleared from the area above the faint line that runs the length of the egg. Photo: S. Brookbanks.

transverse sections. The C.T. images showed that some large fragments of eggshell were buried inside the egg (Fig. 2), suggesting that what had been evident as a large hole in the side of the egg had formed by the collapse of fragments to the interior.

The conservation treatment was conducted by SC. Using the scanned images as reference, most of the sediment from inside the egg was carefully removed, starting from the centre of the area of exposed sediment. The thin previously-consolidated outer surface of the sediment, and much of the looser sediment beneath, was easily removed with metal dental tools and a dental aspirator. A soft brush was used when close to embedded fragments. A layer of sediment 10-15 mm thick was retained inside the egg to hold the outer fragments in place (Fig. 3). A sample of sediment was kept for future reference. The embedded fragments, once exposed, were found to be as weathered as the main shell. We had hoped that these would be unweathered, and allow accurate measurement of shell thickness. Since there was no advantage in removing them, they were left *in situ* (Fig. 3).

A few small, extremely thin pieces of shell became detached, or crumbled into tiny fragments, during the removal of sediment. The larger shards (c. 3 x 1 mm) were adhered in place using

Fig. 2. C.T. scan of presumed moa egg (B4016) in sagittal plane; blunter end to left. A large fragment of shell (arrowed), viewed edge-on, lies embedded in the sediment that fills the egg. The dark, branching lines are possibly cavities left by the roots of plants. Where the sediment was removed right of the collapsed eggshell fragment, the pale, globular shadows proved to be of no consequence. Image: M. Osborne.

Fig. 3. Presumed moa egg (B4016) after conservation treatment, blunter end to left, showing the fragments inside the egg exposed by removal of sediment. Note the weathering of the outer shell surface, and the layer of sediment left inside the egg to hold it together. Photo: S. Cooper.

5% w/v Paraloid B72 acrylic resin in acetone or toluene. Minute pieces which were impossible to relocate were retained in polypropylene bags. Cracked fragments of shell, still attached to the main shell, were adhered in place with 20% w/v Paraloid B72 in acetone. A heated spatula was used at various temperatures to re-adhere a delaminated flap of consolidant film (from previous treatment) on the outside of the egg. After several unsuccessful attempts, it was adhered using 5% w/v Paraloid B72 in acetone.

A small section of sediment against the inside wall of the egg was friable, and was consolidated with 2% w/v methyl cellulose in distilled water. Two areas of excess sediment on the outer surface of the shell were removed mechanically with a scalpel after softening with distilled water. Hardened residues were removed by swabbing with a non-ionic detergent (1% v/v Synperonic N in distilled water) rinsed with distilled water.

A special storage box for the egg was constructed from archival-quality materials.

RESULTS

PETROGRAPHIC ANALYSIS

W.A. Watters (pers. comm. 1987) commented as follows on the sample of sediment that he examined:

> The sediment is fairly well sorted and ranges mainly between silt and fine sand, although a small number of relatively coarse grains (up to 0.5 mm across) are also present. It is thus too coarse-grained to be termed a loess; moreover, it is not as well sorted as typical loess. I would say that it had probably been deposited by water, but because of the absence of clay it may have been winnowed by wind action to some extent. The main mineral grains present are quartz, feldspar, chlorite, epidote, minor biotite, and accessory actinolite, sphene, and opaque grains. Although an overseas source cannot be definitely ruled out, the above minerals, as well as their relative proportions, are consistent with derivation from greywacke, a hard quartzo-feldspathic

> sandstone which makes up much of the axial ranges in both the North and South Islands [of New Zealand]. In my opinion, the sediment is more likely to be from the South Island; if pressed for a narrowing of this source, I would suggest somewhere east of the Southern Alps. Compacted rocks of similar mineralogical composition are widespread, not only among the younger sedimentary beds of southern Marlborough, Canterbury, and North Otago, but similar sediment sorted by stream and wind action, occurs widely in the beds of the large rivers in the eastern part of the island. In conclusion, judging from the general appearance and mineral content of the sediment, I would favour a New Zealand, probably South Island, source.

SIZE AND SURFACE FEATURES

The external dimensions of the egg are approximately 208 x 134 mm, precision being ruled out by damage at the critical points of measurement. Known moa eggs are 120-240 mm long by 91-178 mm wide (Gill 2000), so B4016 is within the known size-range for moas. It is large enough to have belonged to one of the medium- to large-sized species of moas.

In shape the egg is "long oval" (Campbell & Lack 1985), that is, almost elliptical but with one end slightly blunter than the other. The ratio of length to width (1.55) is slightly higher than for other moa eggs (1.25-1.49; see table 1 of Gill 2000).

The "upper" outer surfaces of the egg, including the fragments that had collapsed and been subsequently buried by sediment, are extremely weathered. The shell in places has eroded away to a paper-thin layer (see Fig. 3 and edge of shell exposed in Fig. 2). This part of the egg had the greatest exposure to weathering, and must have become weathered before the parts collapsed inside the egg.

The "lower" outer surfaces (Fig. 1) vary in degree of weathering, and must have been shielded by sediment for much of the time. The surfaces of the least weathered areas clearly display slit-like pore openings. These are a feature of large moa eggs (see, for example, the description of such pores by Archey (1931) from the surface of thick eggshell fragments from Doubtless Bay, Northland).

Shell thickness is measurable only on fragments exposed at the edge of the large hole. All these fragments are weathered but the least damaged piece is at least 1.5 mm thick. Moa eggshell is 0.50-1.78 mm thick (Gill 2000), so B4016 is of a thickness consistent with a thick-shelled moa egg, as expected from its size.

DISCUSSION

The possibility that the unlocalised egg B4016 belongs to any of the living ratites is ruled out by overall dimensions, surface texture and shell thickness. For example, the egg is too small and thin-shelled to be ostrich (*Struthio*), too large and thick-shelled to be kiwi (*Apteryx*), while emus (*Dromaius*) and cassowaries (*Casuarius*) have eggs with a characteristic rough surface.

Less easy to eliminate are the fossil eggs of extinct ratites, or other large birds, from Australia, Madagascar and elsewhere. However, much evidence points to the egg being from New Zealand. The characteristics of the sediment agree with a New Zealand source, and overall dimensions, the kind of surface pores, and shell thickness, are typical of the condition in moas. We conclude that B4016 is probably the egg of a medium- to large-sized moa from the eastern South Island of New Zealand. Of the 18 moa eggs listed in table 1 of Gill (2000), all but four are from the eastern South Island, including all eggs 160 mm long or longer.

C.T. scans of the egg before treatment were a useful tool in revealing the buried eggshell fragments and indicating their exact position. This allowed the removal of sediment to proceed with confidence and precision. C.T. scanning was chosen in preference to conventional X-ray studies because the radiographer advised it would provide superior spatial and contrast resolution.

Careful consideration was given to the consolidant used on the small area of sediment requiring treatment. Three consolidants were tested on samples of removed sediment: 5% w/v Paraloid B72 in toluene, 20% AYAA:AYAC w/v polyvinyl acetate resin 50:50 in toluene, and 2% w/v methyl cellulose in distilled water. Methyl cellulose was chosen because it least altered the colour of the sediment. The other two consolidants penetrated well but noticeably darkened the surface colour of the sediment. Methyl cellulose could interfere with attempts at carbon-dating eggshell that it had contacted. For this reason the area in question has been sketched and noted in the egg's documentation.

Acknowledgements. We thank the New Zealand Lottery Grants Board for funding SC's work on the moa egg; W.A. Watters for the petrographic analysis of the sediment; Dr Mark Osborne and Margaret Bowcock of the Mercy Hospital, Auckland, for conducting the C.T. scan; Carol Diebel for scanning the three photographs; Julia Gresson (Auckland Museum) for conservation advice throughout the project; and Mark Osborne, Julia Gresson and a referee (Prof. John Buckeridge) for helpful comments on a draft of this paper.

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A REVISION OF THE GENUS *PHENACOHELIX* SUTER, 1892 (MOLLUSCA: PULMONATA) WITH DESCRIPTIONS OF FOUR NEW SPECIES AND REASSIGNMENT OF *THALASSOHELIX ZICZAG* (GOULD, 1846)

J.F. GOULSTONE
(Deceased)

Abstract. Four new species in the genus *Phenacohelix* Suter, 1892 are described from New Zealand: *P. aurea* from Auckland north, *P. brooki* from a limited area in the north-east of the North Island, *P. hakarimata* from the middle of the North Island, and *P. mahlfeldae* from Otago, Southland and Stewart Island. *Thalassohelix ziczag* (Gould, 1846), from the northern half of the North Island, is transferred to the genus *Phenacohelix*. *P. ponsonbyi* (Suter, 1892) is redescribed, and details of anatomy are supplied for *P. giveni* (Cumber, 1961), *P. lucetta* (Hutton, 1884), *P. perplexa* (Murdoch, 1897), *P. tholoides* (Suter, 1907) and the type species *P. pilula* (Reeve, 1852).

KEYWORDS: *Phenacohelix*; *Thalassohelix*; *P. aurea* n. sp.; *P. brooki* n. sp.; *P. giveni*; *P. hakarimata* n. sp.; *P. lucetta*; *P. mahlfeldae* n. sp.; *P. perplexa*; *P. pilula*; *P. ponsonbyi*; *P. tholoides*; *P. ziczag*.

INTRODUCTION

In the most recent revision of *Phenacohelix* Suter, 1892, Cumber (1961) divided the genus into two sub-genera, *Phenacohelix* s. str. for *P. ponsonbyi* (Suter, 1897), *P. pilula* (Reeve, 1852) and *P. subantarctica* Suter, 1909, and *Neophenacohelix* Cumber for *Phenacohelix* (*Neophenacohelix*) *giveni* Cumber, 1961, *P.* (*N.*) *tholoides* (Suter, 1907), *P.* (*N.*) *perplexa* (Murdoch, 1897) and *P.* (*N.*) *stokesi* (Smith, 1884). While Cumber's work was evidently thorough, with taxon diagnoses on shell and radular characters, and information provided on distribution, shell variation and ecology, *P. subantarctica* was subsequently transferred to the punctid genus *Laoma* by Climo (1969). Furthermore, Powell (1979) did not adopt Cumber's subgeneric classification of *Phenacohelix*. Powell (1979) recognised that *P.* (*N.*) *stokesi* was synonymous with *P. lucetta* (Hutton, 1884), the latter having priority.

In this paper I revisit all previously described species of *Phenacohelix* from the viewpoint of anatomy, and describe four new species on the basis of conchological and anatomical characters. Further, I describe the anatomy of *Thalassohelix ziczag* (Gould, 1846) and, on the basis of conchological and anatomical characters, transfer this taxon to the genus *Phenacohelix*. Powell (1979) had noted the uncertain status of the genus *Thalassohelix* Pilsbry, 1892 and that *T. ziczag* has no great shell similarity with the type species *Thalassohelix zelandiae* (Gray, 1843). This and my earlier studies (Goulstone 1995, 1996) clearly point to anatomical investigation providing for different interpretations of affinities than that arrived at by studies of shells or radula alone, which has been the more traditional approach. In this present study, I have retained

for the sake of nomenclatural stability all examined species within *Phenacohelix* though anatomical details suggest possible domicile elsewhere. Their proper assignment to genera must await improved understanding of the anatomy of the New Zealand Charopidae.

METHODS

The taxon descriptions and distributions given in this paper are based mainly on specimens held in the Auckland Museum. Accession numbers preceded by "AK" indicate specimen material used in anatomical studies and/or referred to in developing the taxon descriptions. Accessions designated by "AK-L" signify specimens examined during the present study but held in the collections as bulk site samples. For *P. lucetta* and *P. perplexa* I have not listed "Other material examined" as the data presented by Cumber adequately depicts the distribution of these taxa as indicated by the material in the Auckland Museum collections. In the case of *P. ziczag*, *P. pilula* and *P giveni*, the Auckland Museum holdings are too large to contemplate listing all locality data (for *P. giveni*, for example, there were at the time of preparing this manuscript, some 900 registered accessions). Selected, additional material was examined from Museum of New Zealand Te Papa Tongarewa (formerly National Museum of New Zealand), Wellington (accessions designated by MONZ). All collection dates are for the 20th century, and all geographic position co-ordinates for localities refer to eastings and northings in the NZMS 260 map series.

The dimensions of the shells were determined by callipers. The height measurements for shells with preserved animals are usually approximations as the partially retracted animals often partially obscured the shell aperture. Tables of shell measurements of most of the specimens dissected are supplied in "Remarks". Shell colours were determined by placing the dry specimens under the microscope on Munsell's Soil Colour Charts (1994). In the taxon descriptions, shell colours are given for fresh shell specimens, with the colour first defined in words and then by the chart (e.g., 5YR) and swatch (e.g. 8/2) numbers. Animals preserved in alcohol or formalin were dissected under a stereomicroscrope. Tissues from dissected animal have been retained in the Auckland Museum collections, often with the fragments of shell from which the animal had been extracted.

SYSTEMATICS

Family CHAROPIDAE Hutton, 1884
Subfamily AMPHIDOXINAE Albers, 1850

Genus *PHENACOHELIX* Suter, 1892

Phenacohelix Suter, 1892. Transactions of the New Zealand Institute 24: 270. Type species, by subsequent designation, *Helix pilula* Reeve, 1852.
Neophenacohelix Cumber, 1961. Transactions of the Royal Society of New Zealand 1: 164. Type species, by original designation, *Phenacohelix* (*Neophenacohelix*) *giveni* Cumber, 1961.

REMARKS

Suter (1892) designated *P. ponsonbyi* Suter, 1892 as the type species of *Phenacohelix*, which is represented in the two main islands of New Zealand. However, Powell (1979) showed that the type should more properly have been *Helix pilula* Reeve, 1852. The type specimen of *H. pilula* in The Natural History Museum, London, as discussed by Cumber (1961), is in poor condition and only bears the locality designation "New Zealand". Photographs of this type specimen,

held by the Museum of New Zealand, show that it is conchologically identical with the material treated in the present paper as *Phenacohelix pilula* (Reeve) and for which I have supplied a description of the anatomy.

The anatomical information provided by Solem (1978) for *Phenacohelix pilula*, based on specimens obtained by Laurie Price from Kaitaia, actually relates to *Phenacohelix aurea* n. sp. (see below) and, with the type concept in mind, cannot therefore be taken as indicative of the anatomical features of the genus *Phenacohelix*.

Phenacohelix aurea n. sp.

Figs 1, 12

Phenacohelix pilula: Solem, 1982: 62. Not *Helix pilula* Reeve, 1852 = *Phenacohelix pilula* (Reeve, 1852).

ETYMOLOGY

From *aurea*, Latin, golden.

DESCRIPTION

Shell

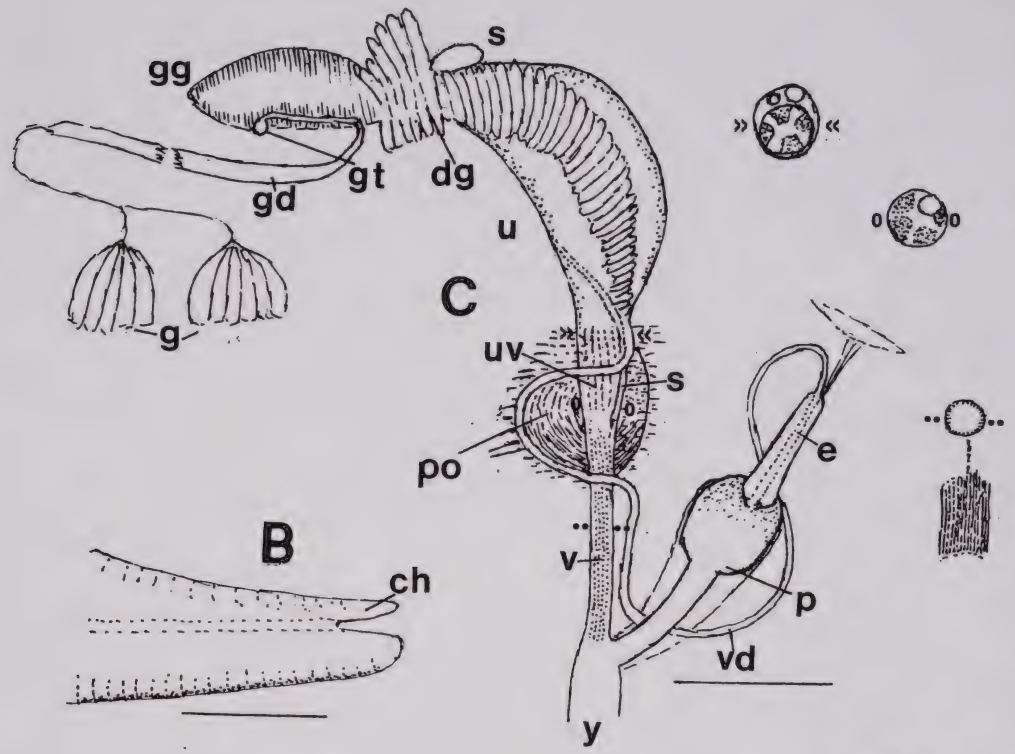
Small, globose, narrowly perforate, with umbilicus partly closed by reflected columella, sutures moderately deep. The type shell, from an adult specimen, is c. 3.3 mm high by 2.9 mm wide, five and a quarter whorls, final whorl 0.2 of total shell diameter. Protoconch of one whorl, 0.15 of total shell diameter in the type, with c. 12 spiral striations. Teleoconch whorls have strong primary axial ribs, sharp at their apex, with crowded fine secondary axials along their bases and in the interstices. First teleoconch whorl with 30 primary axials, the last whorl with 50 primary axials. Axials emerging at right angles from the sutures, but soon curving slightly (at the shoulder) to mirror the shape of the peristome at which accretionary shell growth occurs. On ventral surface these axials are sinuous and terminate in the umbilicus. Teleoconch whorls have crowded microscopic spiral striations, more obvious in the umbilicus and at the suture, but not apparent at the apex of the primary axials. Colour uniformly brown 7.5YR/5/4 when fresh, but shells from dead animals fade quickly to very pale brown 10YR/8/3. Table 1 gives shell measurements for this species.

External Morphology

Mainly white. Caudal horn prominent on foot posterior with pedal groove ending in a deep caudal foss. Margins of the foot sole not much crenellated.

Reproductive Anatomy

Ovotestis comprising two primary clusters of alveoli, embedded in digestive gland close to stomach apex; proximal cluster (about 0.8 mm wide) larger than distal cluster (0.5 mm wide). Ovotestis feeds into the hermaphrodite duct that at first has a very narrow lumen, but its greater part is distended as a seminal vesicle. Hermaphrodite duct with a short, tapered distal section that enters the carrefour embedded at the base of the globular albumen gland (1.2 mm long), and gives rise to a talon comprising a spherical seminal receptacle on a elongated, narrow shaft. Spermoviduct with wide proximal section dominated by prostatic alveoli abutting the albumen gland, but greater part of its length dominated by oviductal glands, over which traverses a narrow band of prostatic alveoli to terminate in the vas deferens. Total length of spermoviduct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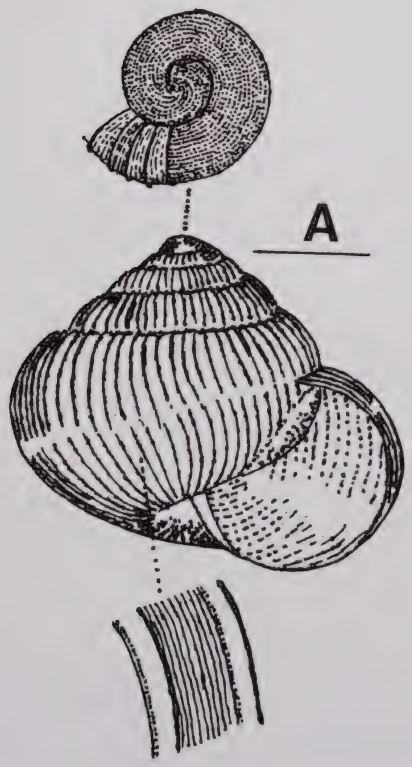
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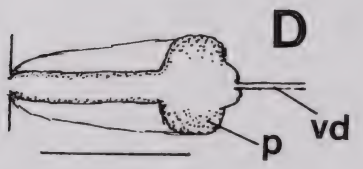
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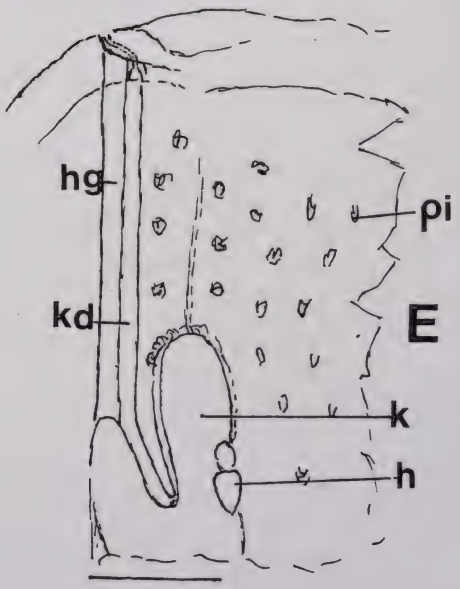
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Table 1. Structural features of the shell of *Phenacohelix aurea* n. sp. based on measurements of representative shells of adults from selected localities. Shell parameters: 1 = width; 2 = height; 3 = whorls; 4 = protoconch width; 5 = last whorl width; 6 = umbilicus width; 7 = number of ribs on 1st teleconch whorl; 8 = number of ribs on last teleconch whorl.

Locality		Shell parameters							
		1	2	3	4	5	6	7	8
1	South Kaipara Head	2.8	2.5	4.8	0.2	0.2	0	32	50
2	South Kaipara Head	2.9	2.7	4.9	0.2	0.2	0	33	52
3	South Kaipara Head	3.2	2.8	5.2	0.6	0.5	0.2	40	68
4	Matakana	2.9	2.7	4.8	0.2				
5	Titirangi	2.6	2.4	4.5	0.2				
6	Parakao	3.0	2.8						
7	Parakao	3.0	2.8						
8	Lion Rock, Piha	3.0	2.4	4.8	0.5	0.5	0.2	39	72

1,2,3. AK154652, G.M. Barker; 4. AK151635, B.F. Hazelwood; 5. AK150874, J.F Goulstone; 6,7. AK81264, A.W.B. Powell; 8. AK155642, B.F. Hazelwood.

1.6 mm. Free oviduct short (0.8 mm long), comprising a slightly bulbous, thick-walled tube (0.3 mm at widest) whose lumen comprises closely-packed longitudinal folds. Vagina long (up to 1.6 mm), rather slender, with fine, longitudinal, closely-spaced, raised ridges running internally. Free oviduct and proximal section of vagina in a pocket surrounded by a layer of connective, muscular tissue that is thickest and fleshy where it attaches to the proximal vagina. Pocket sometimes contains finger-like projections but no discernible opening could be found into the vagina. Vas deferens initially scribing a loop, ear-like in profile, usually fastened to the outside of pocket but sometimes partially embedded within the connective tissue. Remainder of vas deferens only weakly connected to terminal genitalia by connective tissue, terminating at apex of epiphallus. Spermathecal duct a fine tube, embedded in the surface of the free oviduct and spermoviduct for much of its length, before terminating in an oval sac (0.4 mm long) buried amongst the prostatic alveoli near the albumen gland. Epiphallus a thick, straight tube (0.8 mm long), with the short penial retractor muscle arising from its apex, adjacent to the entry of the vas deferens, to attach to the diaphragm near the kidney apex. Penis (1.1 mm long) comprises two sections, a proximal, bulbous chamber (0.5 mm long) into which protrudes the epiphallus apically (forming a vergic papilla), and a distal tubular section (0.6 mm long) with thick, muscular walls. The lumen of the penis is smooth but for some fine palisters and ridges around the vergic papilla. The condition in some specimens indicates that, during mating, the

Fig. 1 (opposite). Shell and anatomy of *Phenacohelix aurea* n. sp. Scale lines = 1 mm. A. Shell of holotype, AK73168. B-E. AK81264, Parakao. B. Posterior portion of foot. C. Reproductive organs. D. Everted penis. E. Pallial organs ventral view.
Abbreviations for Figs 1-11: b, buccal mass; be, oesophagus; br, buccal retractor muscle; ch, caudal horn; cr, columellar retractor muscle; dg, prostate gland; e, epiphallus; fs, foot grooves; g, ovotestis; gd, hermaphrodite duct; gg, albumen gland; gt, talon; h, heart; hg, hindgut; k, kidney; kd, ureter; mc, mantle collar; mg, mucous gland; mu, muscle; n, needle (dart); og, salivary glands; p, penis; pc, penial caecum; pg, pedal ganglia; pi, black or white pigment; po, pocket; pp penial pilaster; pr, penial retractor muscle; ps, penial sheath; rs, radula sac; s, spermathecal shaft and sac; ss, spermathecal duct and sac; u, spermoviduct; uv, free oviduct; v, vagina; vd, vas deferens; y, atrium.

penis contracts and the epiphallus protrudes into the penial lumen to present the vergic papilla at the distal extremity of the penis (Fig. 1D) before the penis is entirely everted.

Other Anatomy
Pallial cavity (3.1 mm long), with the mantle tissue possessing some black pigment that is easily visible through the shell of the live animal. Kidney bilobed, its pericardial lobe longer (1.5 mm long) than its rectal lobe. Ureter a closed tube for its entire length to terminate at excretory orifice near the pneumostome; primary and secondary sections forming V-shaped juncture between lobes of the kidney, with sections partially appressed in mature animals. Pericardium containing the heart (0.6 mm long) recessed into the lateral margin of the kidney.

REMARKS
The above description of the shell was based on the holotype. Eight specimens were dissected, some of which had been preserved in formalin and the shells partially dissolved. In the dissected snails there was considerable variation in the length of the epiphallus and the distal tubular section of the penis. Nonetheless, the solid, ovoid proximal section of the penis and the rigid, straight epiphallus were always present and therefore diagnostic. The pocket around the oviduct and proximal vagina, though varying in shape and size, was also a notable feature. The reproductive structures within the pocket were difficult to access during dissection due to the fibrous nature of the connective tissue. Solem (1982) described this as a 'vaginal pocket' but its exact function remains to be determined. One specimen dissected had the penis everted (Fig.1D) with a section of slender vas deferens at its apex. Another had the narrow base of the spermathecal duct separate from the oviduct.

Solem (1978) published on the anatomy of *Phenacohelix* specimens obtained by Laurie Price from Kaitaia. This was not the species represented by the type specimen of *Phenacohelix pilula*. Instead it is *Phenacohelix aurea* n. sp. The anatomical findings of Solem (1978) and of the present study generally agree well.

TYPE LOCALITY
South Kaipara Head, Lake Ototoa Scenic Reserve, in fallen nikau fronds (*Rhopalostylis sapida*), 67 m, Q09 222215.

HOLOTYPE
AK73168, 3.3 mm x 2.9 mm, J.F. Goulstone 21/8/98.

PARATYPES
AK73169 (2), from type locality, J.F. Goulstone 21/8/98. MONZ 127803 (3), South Kaipara Head, G.M. Barker 21/10/78.

OTHER MATERIAL EXAMINED
Kaitaia O04 412814, L. Price 5/11/78, AK153503. **Maungataniwha** O04 589710 400 m, P.C. Mayhill 1/11/87, AK154662. **Mangatete Scenic Reserve** O04 446834 60 m, P.C. Mayhill 1/3/88, AK154690. **Paranui Scenic Reserve** O04 519811 110 m, P.C. Mayhill 1/9/87, AK154700. **Awanui** O04, AK64465. **Taipa** O04, A.W.B. Powell 1/1/50, AK82947. **Oruru Valley** O04 575824, J. Kenerdine, AK82970. **Mangamuka** O04 585703, J.F. Goulstone 1/1/69, AK82971. **Te Whau** P04 912721, N. Douglas 6/6/69, AK152145. **Waiare Rd.** P04 839748 70 m, P.C. Mayhill 1/11/87, AK154677. **Waiare Rd.** P04 841748 40 m, P.C. Mayhill 1/10/78, AK156012. **Herekino Gorge** N05, L. Fitzgerald 1/1/69, AK82972. **Mangamuka** O05 546674, D. Hole 17/3/72, AK154120. **Mangamuka** O05, A.W.B. Powell

1/1/38, AK829602. **Mangamuka** AK89026; O05 591614, N. Douglas 3/1/70, AK-L21050. **Mangataipa Scenic Reserve** O05 594615 20 m, P.C. Mayhill 1/1/91, AK154879. **Paihia** P05 972579, A.W.B. Powell 1/8/47, AK153694. **Puketi** P05 785603 220 m, P.C. Mayhill 1/10/86, AK154686. **Waipoua Forest** O06 623165, J.F. Goulstone 1/4/89, AK82964; AK82965; O06 2/5/68, AK82973; O06 623165, N. Douglas 29/12/68, AK-L21032; O06 623165, D. Hole 24/4/77, AK154311; O06, D.H. Graham 11/12/28, AK82948; O06 588213 365 m, N. Douglas 29/5/71, AK-L21152. **Yakas Track** O06 602181 240 m, P.C. Mayhill 1/1/90, AK156049. **Waiotemarama** O06 505298, J.F. Goulstone 1/4/89, AK-L3367; O06 505290, J.F. Goulstone 1/5/90, AK-L20900. **Opononi** O06, W. La Roche 1928, AK82951; O06, A.W.B. Powell 2/5/68, AK82955. **Waima Forest** O06 515345, J.F. Goulstone 1/5/90, AK-L10941. **Waimamakau R.** O06 486240, J.F. Goulstone 1/5/90, AK152559. **Mt Hikurangi** P06 934272 380 m, P.C. Mayhill 1/9/88, AK154877; P06 934269, P.C. Mayhill 1/10/86, AK156029. **Matapouri Bay** Q06 472258 N. Douglas 17/5/72, AK152121. **Whangarei** Q06 316121, J.F. Goulstone 17/1/95, AK96567. **Whangarei A.H. Reed Reserve** Q06 319108, J J.F. Goulstone 17/1/95, AK-L20262. **Whangarei Falls** Q06 316121, J.F. Goulstone 17/1/95, AK-L20266. **Maunganui Bluff** O07 625035, J.F. Goulstone 1/4/89, AK96200. **Tangowahine** P07 928028, J.F. Goulstone 18/1/95, AK96524; P07 926922 A.W.B.Powell 28/10/47, AK82954 AK82978. **Parakao** P07, A.W.B. Powell, AK81264. **Tangiteroria School** P07 056973, J.F. Goulstone 18/1/95, AK96491. **Kirikopuni** P07 973046, J.F. Goulstone 18/1/95, AK96535. **Titoki** P07 087055, J.F. Goulstone 18/1/95, AK-L20267. **Dargaville** P07 814914, N. Douglas 3/1/70, AK-L21150. **Pakotai Scenic Reserve** P07 884092 80 m, P.C. Mayhill 1/9/87, AK154684. **Houto State Forest** P07 929028 60 m, P.C. Mayhill 1/2/80, AK156014; P07 944053 100 m, P.C. Mayhill 1/8/87, AK155971; P07 936028 300 m, P.C. Mayhill 1/9/84, AK156056. **Maropiu Forest** P07 819025 240 m, P.C. Mayhill 1/10/94, AK156065. **Parau Bay** Q07 426024, J.F. Goulstone 20/1/95, AK-L20260. **Coronation Reserve** Q07 296087, J.F. Goulstone 17/1/95, AK-L20261; A.W.B. Powell 16/12/68, AK-L2241. **Whangarei Heads** Q07, AK-L2245. **Mt Manaia** Q07 474967, B.F. Hazelwood 26/10/91, AK-L7842. **Waipu Caves** Q07 333840, B.F. Hazelwood & D. Watson 9/9/84, AK-L3393. **Whatiritiri Scenic Reserve** Q07 154011 160 m P.C. Mayhill 1/7/96, AK154875. **Horokaka** Q07 133917 500 m, P.C. Mayhill 1/11/86, AK156020. **Maungatapere** Q07 185018 340 m, P.C. Mayhill 1/12/81, AK155978. **Waipu Gorge** Q07 332838 100 m, P.C. Mayhill 1/11/86, AK156052; Q08 356700, B.F. Hazelwood 1/4/91, AK(L)10220. **Tokatoka** P08 984712 160 m, P.C. Mayhill 1/10/87, AK155980. **Brynderwyn** Q08 393680, D. Hole 16/7/74, AK154474. **Arcadia Rd.** Q08 223704 120 m, P.C. Mayhill 1/7/87, AK155985. **Tinopai** Q09 237499, J.F. Goulstone 24/2/91, AK-L10078. **South Kaipara Head** Q09 223262 100 m, G.M. Barker 21/10/78, AK154652, AK154588. **Lake Ototoa Scenic Reserve** Q09 222215 67 m, J.F. Goulstone 21/8/98, AK155357. **Warkworth** R09 592328, B.F. Hazelwood 8/4/96, AK151647. **Dome Valley** R09 552363, B.F. Hazelwood 11/1/91, AK-L9401. **Moirs Hill** R09 583261, D. Hole 17/5/74, AK154097. **Omaha Valley Rd.** R09 654435, B.F. Hazelwood 4/6/90, AK150496. **Omaha Valley** R09 657420, B.F. Hazelwood 1/9/89, AK-L3396. **Matakana** R09 651376, B.F. Hazelwood 8/4/96, AK151635. **Omaha State Forest** R09 628415 180 m, P.C. Mayhill 1/8/87, AK156025. **Waitakere Ranges** Q11 & R11 many sites, AK64464, AK64466, AK82950, AK82952, AK82953, AK82956, AK82958, AK82960, AK82963, AK82967, AK82968, AK82969, AK82974, AK82975, AK82976, AK82977, AK150874, AK154257, AK154459, AK155641, AK155642, AK-L20494, AK-L21471, AK-L21613, AK-L3283, AK-L3287, AK-L4340. **Waiuku** R12, Rev. W.H. Webster, AK42827, AK25706, AK82966. **Waiuku** A.W.B. Powell 24/7/27, AK82961. **Waipipi Scenic Reserve** R12 580412 50 m, J.F. Goulstone 1/12/76, AK82959, 31/10/97, AK154268. **Paerata Scenic Reserve** R12 788462, J.F. Goulstone 1/10/85, AK-L2308. **Colebaker Ridge** R13 670235 200 m, P.C. Mayhill 1/6/83, AK155548.

DISTRIBUTION AND HABITAT

Phenacohelix aurea n. sp. is distributed from Kaitaia to West Auckland, and down the west coast to just south of Waikato Heads. The species does not appear to be present in eastern districts of Auckland or in the Hunua Ranges. It is essentially a litter-dweller, achieving high abundance in certain habitats, such as among the basalt boulders at Maunganui Bluff. *P. aurea* is often readily found in litter under kawakawa (*Macropiper excelsum*), karaka (*Corynocarpus laevigatus*), puriri (*Vitex lucens*) and other broadleaf trees and shrubs, and in the fallen fronds of

nikau. The apparent abundance in the Waitakere Range suggested by the amount of material in the Auckland Museum reflects the extent of collecting there over many years, rather than true relative abundance.

Phenacohelix brooki n. sp.

Figs 2, 12

ETYMOLOGY

Named for Fred J. Brook of Whangarei.

DESCRIPTION

Shell

Small, depressed globose, moderately perforate, columella not reflected over umbilicus. Holotype shell 4.6 mm x 2.9 mm, with four and three-quarters, tight whorls. Protoconch smooth, 1.5 whorls, 0.2 of total shell width. Umbilicus 0.2 of total shell width. Teleoconch whorls with close-spaced primary axials, 50 on the first teleoconch whorl, 100 on the final whorl, each broader and strongly constructed at the base, sharp at apex. Interstices with indistinct crowded axial ridges, with occasional tall and very weak spiral lirae that do not impinge greatly on the primary axials. Axials arising at right angles from moderately deep sutures and running very straight on dorsal aspect of the whorl, but becoming sinuous underneath. Background colour very pale brown 10/YR/8/3. Dorsal surface has broad bands, with some finer zigzags and spots between, of reddish brown 5YR/4/3. Ventral surface has fine reddish brown zigzags terminating in the umbilicus.

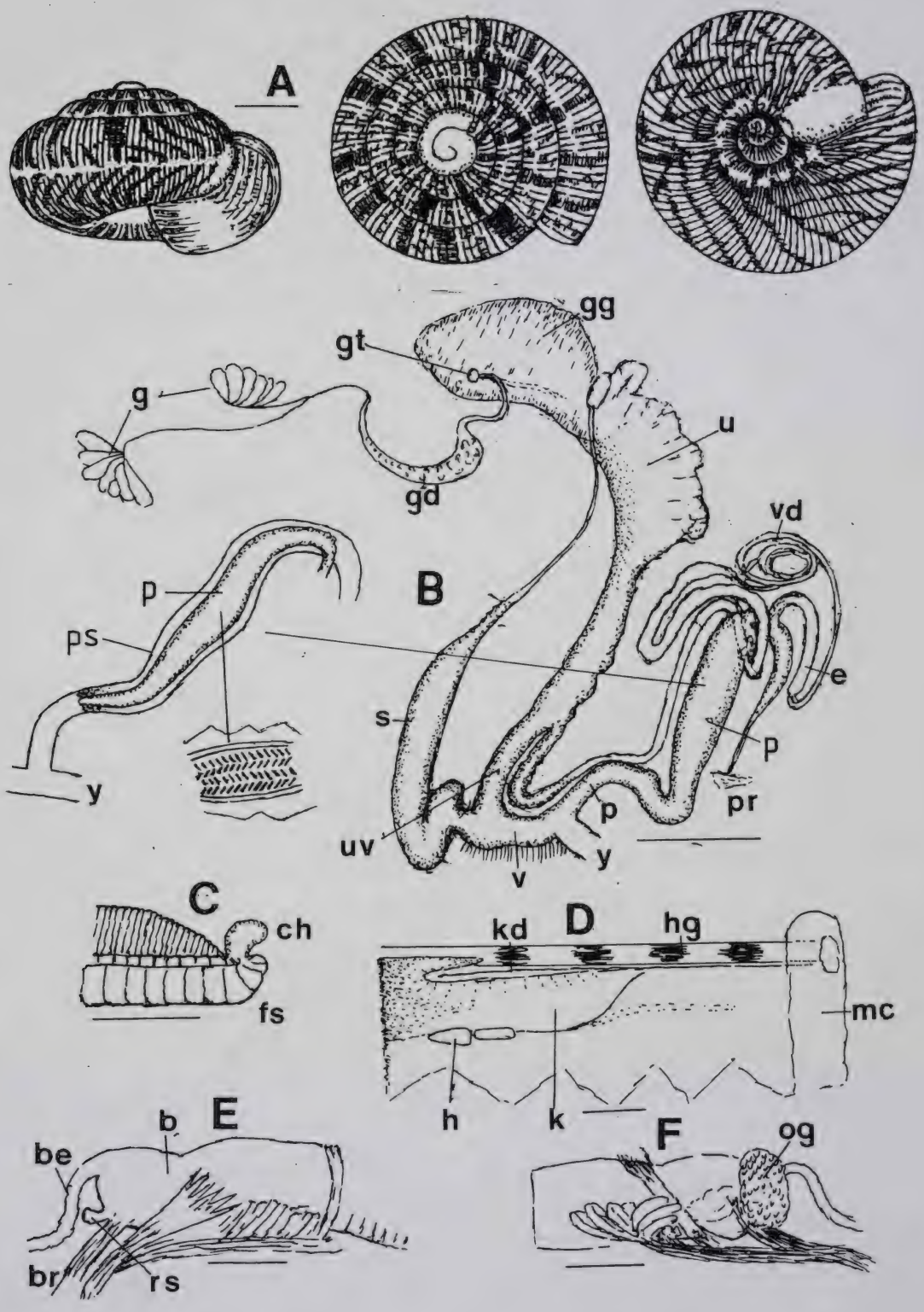
External Morphology

Foot posterior produced to a pronounced caudal horn, but caudal foss only shallow. Foot margin strongly crenellated, surmounted by two pedal grooves.

Reproductive Anatomy

Ovotestis comprising two, discrete clumps of alveoli. Hermaphrodite duct initially very slender; then expands rapidly for 1.1 mm to form a distended, sickle-shaped seminal vesicle; finally narrows to a short section that turns posteriorly to terminate in the carrefour embedded in the ventral surface of the albumen gland. Carrefour yielding a spherical talon, 0.14 mm in diameter. Spermoviduct 2.6 mm long, its proximal half distended, with thick prostatic alveoli and oviductal glands, distal half narrowed to a thick-walled tube. Free oviduct (1 mm long) slightly narrower than distal spermoviduct. Vagina short (0.8 mm). Spermathecal duct long (2.6 mm), distended for approximately half its length, then abruptly narrowing to a fine tube, attached to proximal spermoviduct by connective tissue, and terminating in a small, oblong sac (0.7 mm long) resting against the albumen gland. Vas deferens a very long tube, with a short, thick-walled section where it exits spermoviduct; otherwise thin-walled, most of its length extensively convoluted and coiled, and fastened firmly to the spermoviduct with many layers of fibrous

Fig. 2 (opposite). Shell and anatomy of *Phenacohelix brooki* n. sp. Scale lines = 1 mm (A, B, D) or 0.5 mm (C, E, F). A. Shell of holotype, AK73170. B. Reproductive organs, AK81264. C. Posterior part of foot. D. Pallial organs, ventral view. E. Right-hand side of buccal mass showing retractor muscle attachment. F. Left-hand side of buccal mass showing salivary gland. For key to abbreviations, see Fig. 1.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tissue. Vas deferens terminating at apex of a short, thicker-walled epiphallus. Penis long (1.3 mm), narrow at its proximal apex but broad (0.3 mm at widest) in its middle section below entry of epiphallus, before narrowing slightly to the uniformly tubular distal section. Penis enclosed in a thin sheath. Lumen of penis with multiple rows of short, low, herring-bone ridges over its entire length. Penial retractor muscle fastened to diaphragm near mantle collar.

Other Anatomy
Pallial cavity (7.4 mm long) with considerable black pigment. Kidney with strong pericardial lobe (4.3 mm long) and weak rectal lobe, with no space between kidney and hindgut; ureter running along anterior face of kidney and then along hindgut to excretory orifice at mantle collar. Heart, 0.7 mm long, orientated parallel to long axis of mantle cavity. Buccal mass with very strong retractor muscle fastened prominently along its whole length. Oesophagus entering buccal mass apically, with salivary glands clustered around.

REMARKS
The shell description presented above is based on the holotype. The only animal dissected, a paratype from the type locality, had a shell of 5.2 mm x 3.0 mm, four and a half whorls, with the protoconch 1.1 mm in diameter, last whorl at aperture 1.1 mm in width, first teleoconch whorl with 48 primary axials, the last teleoconch whorl with 106 axials, and with the umbilicus 0.6 mm in diameter.

The shell of *Phenacohelix brooki* n. sp. is remarkably like that of *P. giveni* in size, shape and colour pattern. However, when shells of these two species are viewed side by side the shell of *P. brooki* is consistently smaller, with tighter whorls, and the axials, viewed from the top of the shell, arise at right angles from the suture and maintain that direction with only slight sinuousness to the perimeter. The axial ribs of *P. giveni*, by contrast, slope steadily away from the direction of shell growth. The reproductive anatomy of the two species exhibit numerous differences.

TYPE LOCALITY
Northland, Whangamumu, Karaka Point. Q05 288593–287595.

HOLOTYPE
AK73170, 4.6 mm x 2.9 mm, F.J. Brook 5/11/94.

PARATYPES
AK73171 (4) from type locality, F.J. Brook 5/11/94. MONZ 127801 (2) Whangamumu, Karaka Point Q05 288593, F. Brook 19/9/94.

OTHER MATERIAL EXAMINED
Whakaangi O04 621949 320 m, P.C. Mayhill 1/2/91, AK154663. **Cape Brett** Q05 321685 100 m, F.J. Brook 30/8/93, AK82775; Q05 265620 160 m, P.C. Mayhill 1/11/88, AK154890; Q05 265622 160 m, P.C. Mayhill 1/11/88, AK156015. **Deep Water Cove** Q05 299664, F.J. Brook & J.F. Goulstone 8/12/93, AK154061. **Whangamumu** Q05 281597, A.W.B. Powell 27/9/66, AK154062; Q05 277601 140 m, P.C. Mayhill 1/8/87, AK154860; Q05 280600 80 m, P.C. Mayhill 1/4/81, AK154864. **Ngaiotonga** Q05 237545 140 m, P.C. Mayhill 1/3/96, AK156036; Q05 198488 150 m, P.C. Mayhill 1/10/78, AK156009. **Moturua I.** Q05 188638 70 m, P.C. Mayhill 1/5/81, AK155992.

DISTRIBUTION AND HABITAT
Found with *P. giveni* in litter on the ground, particularly in fallen nikau fronds. The present

known distribution of this snail is very small, all sites near the Bay of Islands except one at Whakaangi in Doubtless Bay.

Phenacohelix giveni (Cumber, 1961)

Figs 3, 12

DESCRIPTION

External Morphology

Margin of foot crenellated, thin, white. Only one pedal groove evident, terminating posteriorly in a caudal foss above which is a pronounced caudal horn. Posterior of foot dark grey to black in dorsal aspect. Head region around and behind ommatophores black.

Reproductive Anatomy

Ovotestis comprising two clumps of finger-like alveoli. Hermaphrodite duct initially slender, then produced to a short, distended section (1 mm long) functioning as a seminal vesicle, then reducing to very short thin tube terminating in the carrefour, and a ovoid talon (0.3 mm long) embedded in the albumen gland. Albumen gland large (2.1 mm long), globular, comprising coarse, crowded alveoli. Spermoviduct ovoid (3.5 mm), with thin band of prostatic alveoli along its entire length, though sometimes wider proximally. Free oviduct a thick tube (1.7 mm long). Vagina absent as both the spermatheca and free oviduct arise from the atrium. Spermathecal duct rather broad proximally, but rapidly narrowing to a very slender duct that terminates in a small, oval sac lying against the base of the albumen gland. Vas deferens emerging from distal extremity of the spermoviduct as fine tube, passing close to atrium through angle of oviduct and penis, to abruptly terminate at the apex of the epiphallus. Epiphallus tubular, comprising two sections of approximately equal length: a thick-walled, proximal section, and a narrower, thin-walled distal section, the latter entering the apex of the penis adjacent to the insertion of the penial retractor muscle. Main body of penis comprising a tubular, somewhat irregularly-shaped proximal section, bearing internally small papilla of which many are armed with crystalline spines orientated towards the atrium, and a slightly narrower, uniformly tubular distal section that evidently has a smooth internal surface. The proximal penis bears a prominent lateral caecum that is initially tubular but terminates in a somewhat bulbous, solid apex. The tubular section of the penial caecum is internally lined mostly with a thick folded epithelium, but for a broad channel running to the penis proper and whose epithelium is produced into small, rounded papillae that carry spines orientated toward the caecal apex. The bulbous apex comprises a chamber packed with fibrous, muscular material, in which is embedded the bulbous base of a hollow dart and associated keyhole-shaped structure. The shaft of the dart produces into the lumen of the penial caecum. Opening into the caecal apex, opposite the keyhole-shaped structure, is a singular, elongate gland, the apex of which is firmly attached to the outer wall of the penial caecum by a short tuft of muscle fibres. The penial caecal complex is of variable length, sometimes barely extending beyond the apex of the penis proper, sometimes stretching far beyond and dwarfing the penis. Penis, and base of the penial caecum, enclosed in a well-developed sheath. The penis retractor muscle arises from the diaphragm in the mid section of the pallial cavity.

Other Anatomy

Pallial cavity 8.5 mm long, kidney 3.5 mm long, heart 1.2 mm long, mantle collar 0.9 mm wide. Pericardial lobe of kidney large, rectal lobe very small. Ureter V-shaped, firstly running

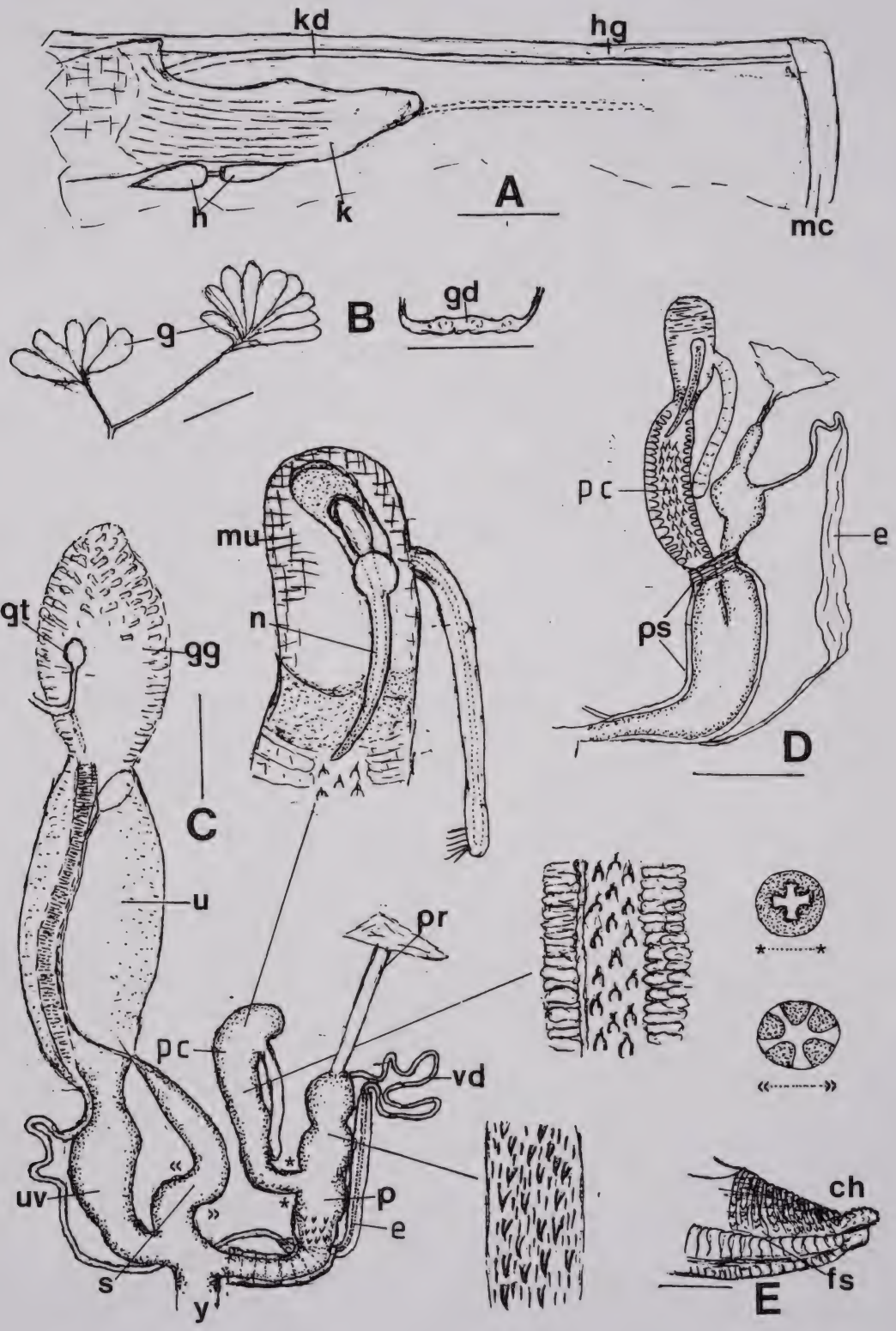
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Table 2. Structural features of the shell of *Phenacohelix giveni* (Cumber, 1961) based on measurements taken from representative shells of adults from selected localities. Shell parameters: 1 = width; 2 = height; 3 = whorls; 4 = protoconch width; 5 = last whorl width; 6 = umbilicus width; 7 = number of ribs on 1st teleconch whorl; 8 = number of ribs on last teleconch whorl.

Locality		Shell parameters							
		1	2	3	4	5	6	7	8
1	Mimiwhangata	5.4	3.5						
2	Wiri	4.8	3.1	4.5	1.1	1.1	0.7	31	75
3	Awakino	4.9	2.8	4.3	1.1	1.1	0.7	37	72
4	Tongaporutu R.	5.3	3.4	4.8	1.1	1.1	0.7	35	70
5	Tongaporutu R.	5.6	3.9	4.8	1.1	1.5	0.6	45	86
6	Pukerimu	6.2	3.4	4.8	1.1	1.3	0.8	41	83
7	Kawau Pa	4.7	3.1	4.3	1.1	1.3	0.6	44	76
8	Lake Tarawera	5.0	2.7	4.8	1.0	1.1	0.6	41	82
9	Lake Tarawera	6.3	4.0	4.8	1.1	1.9	0.6	45	103
10	Waitomo	6.3	3.9	5.0	1.0	1.6	0.8	39	92
11	Lake Rotoiti	5.0	3.2	4.8	1.1	1.3	0.6	46	84

1. AK15215, Q06 369379, F.J. Brook & J.F. Goulstone 20/4/94. 2. AK154039, R11 735633 J.F. Goulstone 7/7/87. 3. AK154569, R17 509807, J.F. Goulstone 7/3/97. 4. AK153580, Q18 485644, J.F. Goulstone & R. Prasad 9/3/97. 5. AK154043, Q18476641, J.F. Goulstone 7/3/97. 6. AK154562, U16 747288 500 m, P.C. Mayhill 1/5/97. 7. AK154569, Q18 490690, J.F. Goulstone 10/3/97. 8, 9. AK154590, 38°11'S 176°26'E, G.M. Barker 1/1/80. 10. AK154821, 37°16'S 175°01'E, G.M. Barker19/9/78. 11. AK154054, V15 137478 380 m, P.C. Mayhill 1/8/97.

along anterior face of the kidney, emerging from kidney tissues before rectal lobe to run adjacent to rectum and open to exterior just behind anus at respiratory pore. Wall of pallial cavity clearly visible between two arms of ureter. Oesophagus exits from the roof of the buccal mass forward of median, dorsal position.

REMARKS

I dissected eleven specimens, whose shell dimensions are given in Table 2. The dart at the apex of the penial caecum was fully preserved in every animal dissected and thus is probably not expendable. The whole penial caecum apparatus looks as if it may function as a syringe. Although the shells of the eleven dissected specimens varied, particularly in the number of ribs, the animals showed only penial variations that were caused by deformities in the penial sheath.

DISTRIBUTION AND HABITAT

Phenacohelix giveni is found throughout much of the North Island, but is absent at Te Paki in the Far North. It is generally an abundant snail in the northern half of the North Island. It can be found easily in fallen nikau fronds, but also in a wide range of litter types, and among rocks.

Fig. 3 (opposite). Anatomy of *Phenacohelix giveni* (Cumber). Scale lines = 1 mm (A, C) or 0.5 mm (B, D, E). A, B, C, E. AK154039, Wiri. D. AK154562, Pukerimu. A. Pallial organs, ventral view. B. Ovotestis and enlarged portion of hermaphrodite duct. C. Reproductive organs. D. Penis and penial epiphallus showing the effect of a deformed penial sheath. E. Posterior portion of foot. For key to abbreviations, see Fig. 1.

It also lives arboreally in nikau trees. Where bush has been trampled by stock in farm lots, and subsequently fenced, it is one of the first species to reappear on the ground. In the southern half of the North Island it is not so abundant, and in some local areas, for example in the Wairarapa, appears to be absent.

Phenacohelix hakarimata n. sp.

Figs 4, 12

Phenacohelix ponsonbyi of authors, not of Suter, 1897.

ETYMOLOGY

Named for the range of hills that contains the type locality.

DESCRIPTION

Shell

Small (6.4 mm x 3.9 mm), depressed globose, four and a quarter whorls, final whorl 0.2 of total shell diameter, height of spire half height of aperture. Protoconch 0.9 mm wide, 1.1 whorls, 0.15 of total shell diameter, with faint, spiral lines. Umbilicus 0.7 mm wide, 0.12 of total shell diameter. Teleoconch with closely spaced axial ribs emerging at right angles from suture, then, on dorsal surface, arcing gently away from direction of shell growth, becoming slightly sinuous on ventral surface. First teleoconch whorl has 37 axials, the last whorl 77 axials. Interstices with fine, closely-spaced secondary axials, crossed by spiral striae of about equal strength. Base colour very pale brown 10YR/8/3 superimposed with flashes and zigzags of reddish brown 5YR/4/3 all over.

External Morphology

Foot margin strongly crenellated, with two pedal grooves above. Posterior of foot without caudal horn, finely grooved on dorsal surface.

Reproductive Anatomy

Ovotestis has two clumps of finger-like alveoli. Hermaphrodite duct starts as very slender tube, but for most of its length (2.5 mm) is distended as a straight seminal vesicle, reducing briefly before entering albumen gland, terminating in carrefour and talon. Albumen gland (1.5 mm) small, evidently very depleted in the dissected specimens. Spermoviduct (2.3 mm long x 1.2 mm wide) sickle-shaped, prostatic alveoli confined to proximal quarter. Free oviduct (2.5 mm x 0.5 mm) thick, folded. Spermathecal duct (1.3 mm long) broad at base, with same diameter as free oviduct, but tapering to a slender tube which terminates in an oblong sac about 0.8 mm long resting against albumen gland. Vagina (1.8 mm long) proximally bulbous reducing to thick tube (0.4 mm wide) before entry to atrium. Vas deferens broad at its origin from distal spermoviduct but soon becomes slender to pass through angle of vagina and penis before entering penis just below apex. Vas deferens continues internally within the penis and open a third of the way down from apex. Penial retractor muscle arising from diaphragm about half way along

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Figs 4, 12

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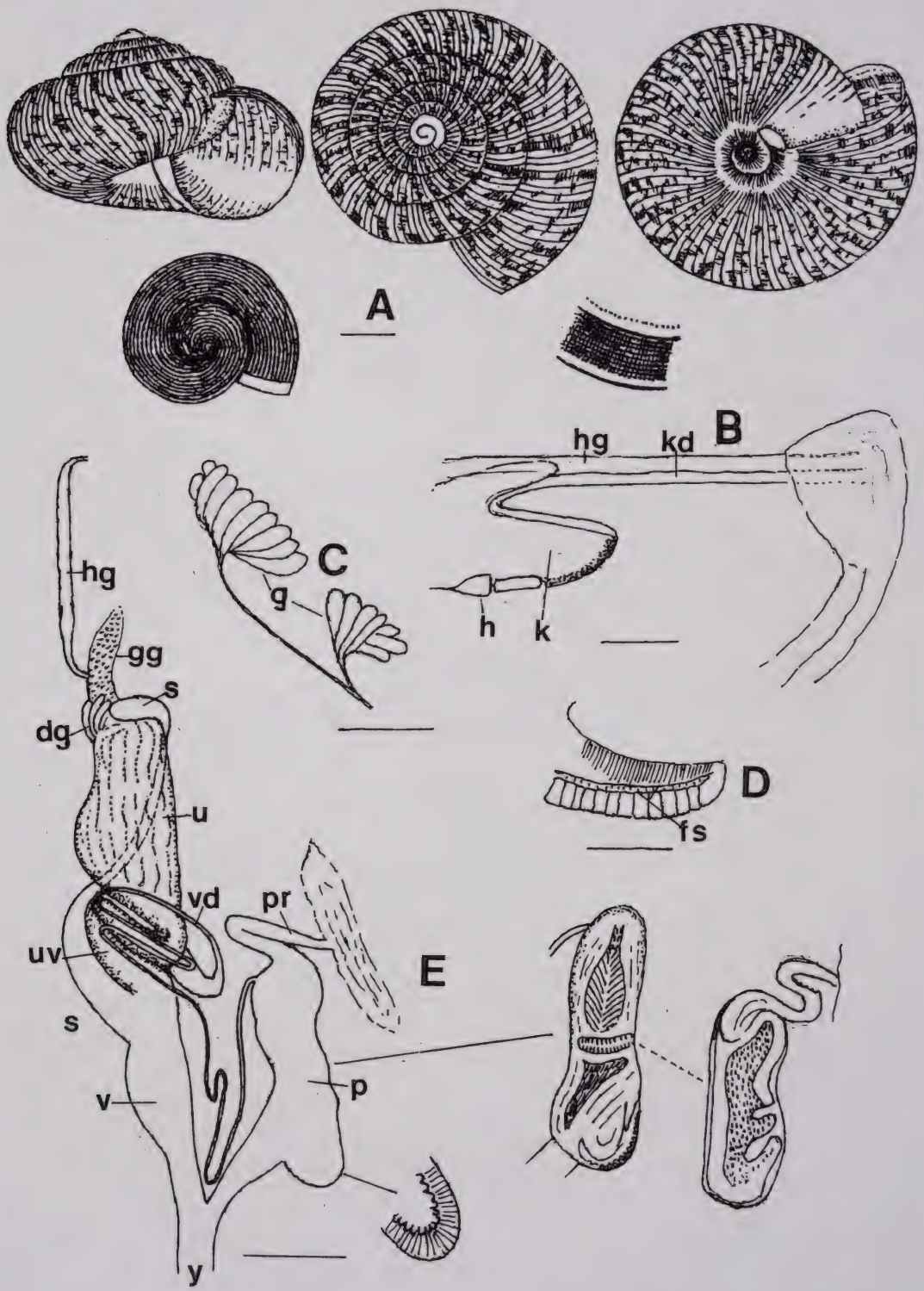
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Table 3. Structural features of the shell of *Phenacohelix hakarimata* n. sp. based on measurements taken from representative shells of adults from selected localities. Shell parameters: 1 = width; 2 = height; 3 = whorls; 4 = protoconch width; 5 = last whorl width; 6 = umbilicus width; 7 = number of ribs on 1st teleconch whorl; 8 = number of ribs on last teleconch whorl.

Locality	Shell parameters							
	1	2	3	4	5	6	7	8
1 Hakarimata	5.9	3.1	4.3	0.9	1.2	0.7	37	77
2 Kaimai	5.5	3.0	4.5	0.9	1.2	0.9	40	106
3 Kaimai	4.3	2.9	4.0	0.7	1.2	0.6	38	84
4 Kaimai	5.2	3.4	4.3	0.8	1.3	0.7	35	83
5 Kaimai	4.3	2.7	4.0	0.9	1.0	0.6	36	76
6 Pirongia	6.4	3.9	4.8	0.9	1.7	1.0	43	117

1. AK154591. 2. AK154579. 3. AK154578. 4. AK154646. 5. AK154592. 6. AK154599. All collected by G.M. Barker.

pallial cavity, to attach at the apex of penis. Penis has elongate, globular proximal section (2.5 mm long x c. 1 mm wide) and distal reducing tubular section, half width of vagina at entry to the atrium. Proximal section of penis has internal irregular protuberances and mixture of low herringbone ridges and short crowded pilasters covering the thick walls. Before entry to the distal penis, this section bulbous, containing fleshy portion with short papillate pad enclosing small semi-circular space with low ridges.

Other Anatomy

Pallial cavity 9.3 mm long, kidney 2.7 mm long, heart 1.6 mm long, mantle collar 1.4 mm wide. Pericardial lobe of kidney large, triangular. Rectal lobe of kidney substantial, narrowly triangular. Ureter starts from apex of pericardial lobe of kidney, follows anterior face of both pericardial and rectal lobes, then follows hindgut to orifice just behind it at the respiratory pore. There is wide space between the reflexed arms of the ureter. There are spots of black pigment over pallial cavity membrane and tip of digestive gland. Oesophagus and saliva ducts enter posterior extremity of the buccal mass, just above the radula sac.

REMARKS

The shell description is of the holotype. The anatomy is based on a composite of the six dissected animals, but substantially on the dissected animal from the type locality. One of the dissected animals (3 Kaimai; Table 3) was sexually immature, without developed genitalia. Another (5 Kaimai) had the reproductive organs formed, albeit small, and only the proximal third of the penis lumen had pilasters. In this young specimen it was easier to see that the vas deferens, though entering near the penial apex, in fact emptied into the penis one third of the way down. All mature specimens dissected had the bulge just before the narrower distal section of the penis, but the function of the partly enclosed space could not be determined.

Phenacohelix hakarimata resembles *P. ponsonbyi* in shell morphology. Whereas *P. ponsonbyi* shells have clearly defined, sharp lirae on the protoconch, those of *P. hakarimata* possessed lirae on the protoconch that were often hard to discern. The lirae were particularly difficult to see in specimens of *P. hakarimata* from the eastern parts of its range. Identification often relies on the recognition of the single-whorled, pointed protoconch in *P. hakarimata*, as opposed to the 1.5

flat whorls in the protoconch of *P. giveni*. The penial complex, however, is clearly different in these two species.

TYPE LOCALITY
Hakarimata Range, S14 973896, 158 m.

HOLOTYPE
AK73172 5.4 mm x 3.8 mm, P.C. Mayhill 1/1/84.

PARATYPES
AK 73173 (14) from type locality, P.C. Mayhill 1/1/84. MONZ 127802 (10) from type locality, P.C. Mayhill 1/1/84.

OTHER MATERIAL EXAMINED
Korapuki Is. T10 648005 40 m P.C. Mayhill 1/3/94, AK156158. **Hot Water Beach** T11 618754 10 m, P.C. Mayhill 1/9/77, AK156043. **Waiomu** T11 362608 180 m, P.C. Mayhill 1/3/81, AK156186. **Kauaeranga Valley** T12 556455, J.F. Goulstone 1/1/79, AK152292; T12 481570, J.F. Goulstone 1/1/79, AK152317. **Kopu-Hikuai Rd. Summit** T12 478468, J.F. Goulstone 5/1/79, AK152347. **Waikawau Cave Reserve** R13 689097 60 m, P.C. Mayhill 1/12/78, AK155555. **Parakiwai** T12 619317 100 m, P.C. Mayhill 1/11/80, AK156022. **Te Aroha** T13 506028, J.F. Goulstone 5/1/97, AK-L21258. **Waitengaue Stream** T13 633069 100 m, P.C. Mayhill 1/11/96, AK155402. **Waitengaue Track** T13 623067 120 m, P.C. Mayhill 1/3/97, AK155545. **Maratoto Valley** T13 559279 200 m, P.C. Mayhill 1/11/78, AK156077. **Komata Reef** T13 538226 240 m, P.C. Mayhill 1/1/79, AK156087. **Waitawheta** T13 561100 200 m, P.C. Mayhill 1/9/82, AK156113; T13 559083, P.C. Mayhill 1/11/96, AK156116. **Wairongomai** T13 545027 320 m, P.C. Mayhill 1/9/79, AK156133. **Waihi Beach N. end** U13 703188, N. Douglas 20/6/71, AK152986. **Cogswell Rd.** R14 893773 100 m, P.C. Mayhill 1/7/78, AK155425. **Hamilton** S14 126784, G.M. Barker 2/8/78, AK154634. **Hakarimata, Waingaro** S14 973896 158 m: P.C. Mayhill 1/1/84, AK155269; P.C. Mayhill 1/9/83, AK155289. **Hakarimata** S14 006967 200 m, P.C. Mayhill 1/8/83, AK155273, 1/12/82, AK155315, 1/9/83, AK155322; S14 973892 60 m, P.C. Mayhill 1/4/79, AK155530. **Whewells Bush** S14 200728 52 m, P.C. Mayhill 1/1/84, AK155272, 1/10/84, AK155281, 1/11/84, AK155306. **Pukemokemoke** S14 198988 102 m, P.C. Mayhill 1/3/83, AK155294, 1/1/84, AK155293. **Taupiri** S14 034974 160 m, P.C. Mayhill 1/1/78, AK155467; H. Suter AK83082. **West of Taupiri** S14, L. Fitzgerald 1961, AK83079. **Four Brothers Scenic Reserve** S14 927728 180 m, P.C. Mayhill 1/7/83, AK155538. **Upper Kaimai, Aongatete** T14 681881 180 m, P.C. Mayhill 1/11/87, AK155824; T14 671879 180 m, P.C. Mayhill 1/12/88, AK155885. **Abseil Rock** T14 614951 500 m, P.C. Mayhill 1/12/86, AK156189. **Wairere Falls** T14 655814 420 m, P.C. Mayhill 1/1/81, AK155836. **Tuahu Track** T14 624961 400 m, P.C. Mayhill 1/4/97, AK155831. **Te Tapui** T14 412733 260 m, P.C. Mayhill 1/8/81, AK155810; T14 452707 340 m, P.C. Mayhill 1/12/84, AK155831. **Mt Eliza** T14 623922 280 m, P.C. Mayhill 1/3/88, AK156145. **Te Tuhi Track** T14 677787 520 m, P.C. Mayhill 1/3/86, AK156171. **Lower Kaimai** U14 795746, G.M. Barker 9/9/78, AK154641. **Kirikiri Dam** U14 982734 200 m, P.C. Mayhill 1/2/95, AK155854. **Puketoki Scenic Reserve** U14 734808 260 m, P.C. Mayhill 1/4/90, AK155875; U14 736810 260 m, P.C. Mayhill 1/12/88, AK155916. **Kawhia-Raglan** R15 737508 60 m, P.C. Mayhill1/11/79, AK155411. **Andersons Bluff** R15 814451 110 m, P.C. Mayhill 1/8/77, AK155413. **Bridal Veil Falls** R15 774645 200 m, P.C. Mayhill 1/4/78, AK155419. **Pirongia State Forest Park** R15 875408 300 m, P.C. Mayhill 1/10/83, AK155572. **Hauturu Rd.** R15 878404 300 m, P.C. Mayhill 1/12/79, AK155397. **Walter Scott Reserve** S15 935454 260 m, P.C. Mayhill 1/7/78, AK155400; T15 326683 210 m, P.C. Mayhill1/9/85, AK155275. **Maungakawa No. 1** T15 325686 200 m P.C. Mayhill 1/9/85, AK155309, 1/3/85, AK155313, 1/4/85, AK155325. **Maungakawa No. 2.** T15 326683 210 m, P.C. Mayhill 1/2/82, AK156058. **Maungatautari** T15 365524 320 m, P.C. Mayhill 1/11/78, AK155462. **Fitzgerald Glade** T15 636577 280 m, P.C. Mayhill 1/7/81, AK156152. **Selwyn Reserve** T15 665513 280 m, P.C. Mayhill 1/7/81, AK156166. **Hanga Rd.** U15 717645 400 m, P.C.

Mayhill1/8/87, AK155796. **Mangatoi Rd.** U15 966623 300 m, P.C. Mayhill 1/3/96, AK156054; U15 959628 300 m, P.C. Mayhill 1/3/96, AK156108. **Woods Mill** U15 711484 500 m, P.C. Mayhill 1/2/84, AK156163. **Mamaku, Galaxie Rd.** U15 777479 560 m, P.C. Mayhill 1/1/82, AK156177. **Rotoiti Scenic Reserve** V15 166486 300 m, P.C. Mayhill 1/11/86, AK156156. **Okataina** V15 116414 380 m, P.C. Mayhill 1/10/84, AK156169. **Ohope Scenic Reserve** W15 644578 40 m, P.C. Mayhill 1/8/79, AK155838. **Kotare Scenic Reserve** W15 714410 80 m, P.C. Mayhill 1/7/93, AK155857. **Motu River** X15, A.E. Brookes, AK155354, L4220. **Opotiki Waterworks** X15 925456 20 m, P.C. Mayhill 1/9/80, AK155816. **Waitomo, Stubbs Cave** R16 834246 340 m, P.C. Mayhill 1/7/78, AK155301. **Tawerau State Forest** R16 828197, P.C. Mayhill 1/8/81, AK155387. **Tawerau State Forest Ecological Reserve** R16 765203 240 m, P.C. Mayhill 1/1/84, AK155389. **Waitomo** S16 946250 G.M. & M.P. Barker, AK154825; S16 945250, G.M. Barker 1/9/89, AK154637; S16 945250 91 m, G.M. Barker 1/9/89, AK155505. **Hamilton Junior Naturalists' Club, Kawhia** 1/1/70, AK155253. **Waitomo, nr. Te Anga Rd.** S16 954198, G.M. & M.P. Barker 2/7/78, AK155374. **Ruakuri** S16 818249 260 m, P.C. Mayhill 1/5/84, AK155406. **Pukerimu Reserve** T16 698273 400 m, P.C. Mayhill 1/4/78, AK156181. **Hora Hora** U16 816288 600 m, P.C. Mayhill 1/11/81, AK156192. **Waimana** W16 694155, J.F. Goulstone 1/5/75, AK83083. **Marawaiwai** W16 883377 40 m, P.C. Mayhill 1/12/96, AK155785. **Hukutaia Domain** W16 844394 60 m, P.C. Mayhill 1/9/80, AK155812; W16 844394 60 m, P.C. Mayhill 1/8/79, AK155818. **Waimana, Wai-iti Track** W16 708133 410 m, P.C. Mayhill 1/4/79, AK155822. **Waioeka-Opotiki** W16 884377 60 m, P.C. Mayhill 1/7/86, AK155815; W16 882378 60 m, P.C. Mayhill 1/7/91, AK155829. **Te Pona a Pita Track** W16 707133 380 m, P.C. Mayhill 1/12/96, AK155863; W16 713133 380 m, P.C. Mayhill 1/12/96, AK155918. **Pakihi Track** X16 994309 120 m, P.C. Mayhill 1/12/94, AK155840. **Whareorino State Forest** R17 609078 340 m, P.C. Mayhill 1/3/83, AK155404; R17 593913 380 m, P.C. Mayhill 1/3/83, AK155409. **Pureora, Hurakia Block** T17 246840, J.F. Goulstone 1/4/82, AK150400, AK150485. **Pureora Information Centre** T17 331954, J.F. Goulstone 1/4/82, AK150351. **Whakatane River** W17 595927, J.F. Goulstone 1/5/77, AK-L20023. **Waikare River** W17 620973, J.F. Goulstone 1/5/79, AK-L20031. **Mangatawhero Stream** W17 580917, J.F. Goulstone 1/5/79, AK-L9096. **Ngatuoha** W17 721083 500 m, P.C. Mayhill 1/9/80, AK155879. **Mt Messenger** Q18 481546, J.F. Goulstone 8/3/97, AK-L21393; Q18 488553, J.F. Goulstone 8/3/97, AK-L21401. **Mokau Scenic Reserve** R18 553764, J.F. Goulstone 10/3/97, AK-L21414. **Waiau River, Parahaki Hut** V18 449660, J.F. Goulstone 1/5/81, AK150727. **Te Waiotekapiti Stream** V18 468610, J.F. Goulstone 1/5/81, AK151001. **Whirinaki** V18 275607, J.F. Goulstone 1/6/91, AK96195; V18 321725 400 m, P.C. Mayhill 1/4/84, AK155573. **Minginui** V18 355825 700 m, P.C. Mayhill 1/4/77, AK155801. **Waikaremoana** W18 570632, J.F. Goulstone 1/11/84, AK-L9400. **Between Te Puna & Marauiti Huts** W18 584636, J.F. Goulstone 1/5/81, AK151037. **Marauiti Hut** W18 570632: J.F. Goulstone 1/5/84, AK151057, J.F. Goulstone 1/5/80, AK151058. **Whanganui Hut** W18 613680, J.F. Goulstone 1/5/76, AK151207, AK83071. **Whanganui Track** W18 614683 700 m, P.C. Mayhill 1/2/82, AK155808. **Moerangi Track** Y18 324730 420 m, P.C. Mayhill 1/4/84, AK155785. **New Plymouth, Huatoki Domain** P19 036353, J.F. Goulstone 1/12/88, AK97943. **Tarata State Forest** Q19 268245 200 m, P.C. Mayhill 1/11/84, AK155493. **Pipiriki South** R21 864894 140 m, P.C. Mayhill 1/11/78, AK155573, AK155498. **Ihupiri Park** R22 897585 480 m, P.C. Mayhill, AK155557. **Aramaho** R22, W. La Roche 1928, AK95912.

DISTRIBUTION AND HABITAT

The preserved specimens dissected were all collected in *Freycinetia*. Others were found on the ground in litter, particularly fallen epiphytes and nikau fronds. *Phenacohelix hakarimata* has a wide range in the central North Island from south of Auckland, southern Coromandel Ranges to East Cape, northern Taranaki and Wanganui.

Phenacohelix lucetta (Hutton, 1884)

Figs 5, 12

DESCRIPTION

External Morphology

Animal mostly white. Foot moderately thick and margin crenellated, surmounted by two pedal grooves that terminate posteriorly in a shallow foss and attendant low caudal horn. Dorsal surface of tail closely grooved.

Reproductive Anatomy

Ovotestis has two clumps of finger-like alveoli, each clump c. 0.9 x 0.7 mm. Hermaphrodite duct proximally very slender, then gradually becoming distended to form a seminal vesicle (2.7 mm long) before narrowing and bending back sharply to terminate in the carrefour, with talon, embedded in the albumen gland. Talon spherical, c. 0.03 mm in diameter. Albumen gland ovoid, of variable size, 2.3 mm long in one dissected specimen. Spermoviduct (4.0 mm long) proximally cylindrical, distally distended, elongate ovoid, with narrow band of prostatic alveoli along its whole length. Free oviduct short (0.6 mm x 0.15 mm), increasing in width towards junction with spermathecal duct and vagina. Spermathecal duct with very broad base, gradually reducing to moderately slender tube terminating in round sac (0.7 mm diameter) resting against albumen gland. Vagina rather long (1.4 mm long), gradually reducing in width towards atrium. Vas deferens of uniform width throughout, passing through angle between vagina and penis close to atrium, to enter the penis apically adjacent to the retractor muscle. Retractor muscle has short, thick, circular, fleshy stalk, arising from diaphragm membrane half way along the pallial cavity close to the columellar muscle. Penis large, broadest at proximal end, gradually tapering to distal entry to atrium. Inner surface of proximal two thirds of penis essentially covered by short, stout papillae, that are slightly more elongated in the area around the vas deferens entry; papillae generally lacking in distal penis. One or more longitudinal depressions evident externally as darker zone(s) in the proximal penis correspond with an internal bridge between opposing walls, resulting with bifurcation of the penial lumen towards its proximal apex. Distal, tubular section of the penis, in some specimens, possesses a distended section.

Other Anatomy

Pallial cavity (8 mm long) has speckled black and white pigment on outer membrane. Kidney with a large pericardial lobe (3.6 mm long) and weak, acutely triangular rectal lobe. Ureter running along anterior face of the kidney and along hindgut to empty through respiratory pore. Wall of pallial cavity easily visible between two arms of ureter. Heart (1.4 mm long) slightly recessed into the outer wall of kidney pericardial lobe. Mantle collar 1.7 mm wide. Oesophagus, and the two salivary ducts, emerge from the roof of the buccal mass slightly forward of median dorsal point.

REMARKS

Six specimens were dissected, three each from the South and North Islands. Although Cumber (1961) noted differences between shells sourced from North and South Island localities, I could detect little difference in anatomy. Terminal genitalia in the South Island specimens dissected tended to be larger, though the shells were smaller. I have not followed up shell differences in this paper. See Table 4 for measurements.

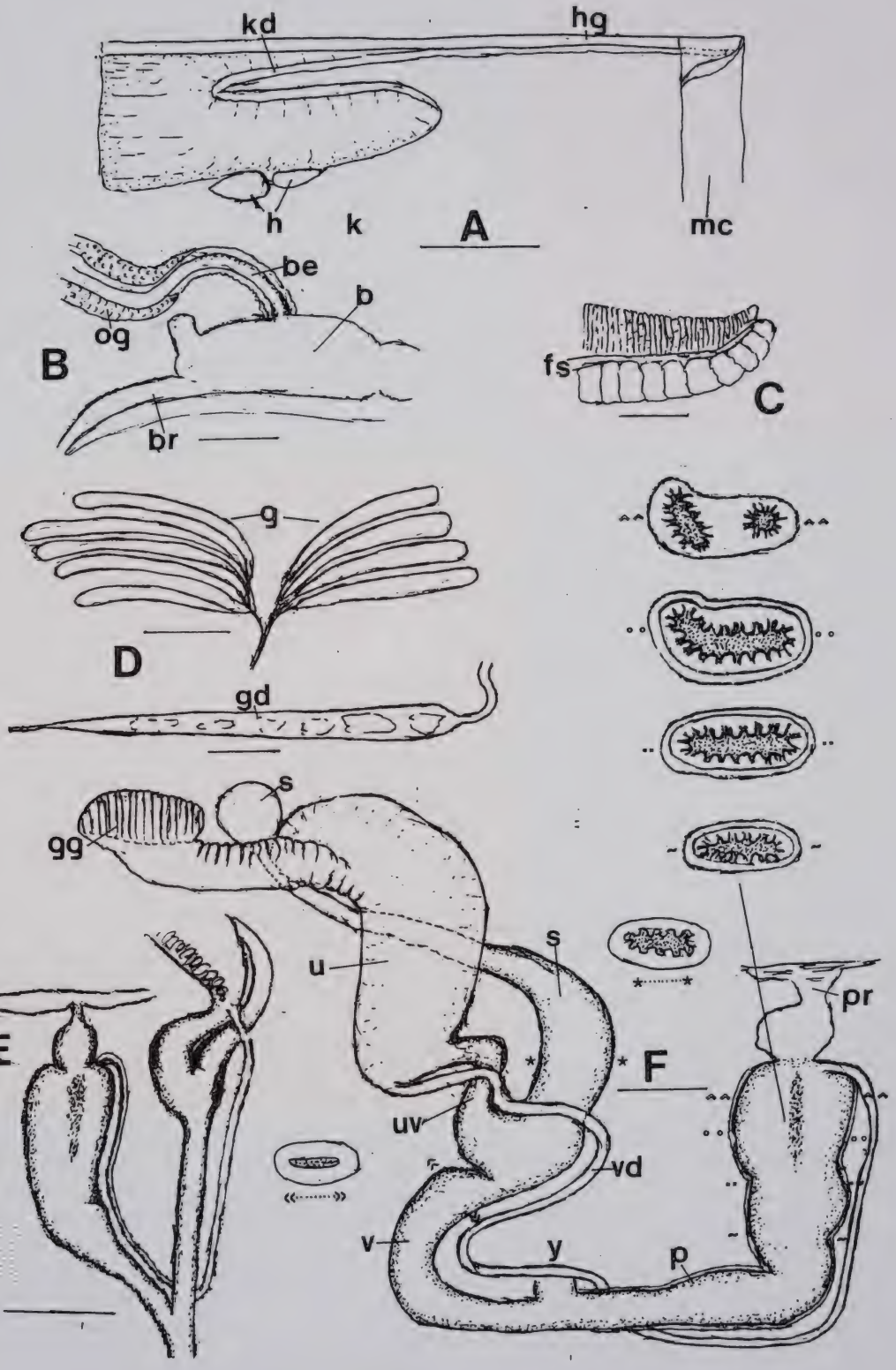
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Table 4. Structural features of the shell of *Phenacohelix lucetta* (Hutton, 1884) based on measurements taken from representative shells of adults from selected localities. Shell parameters: 1 = width; 2 = height; 3 = whorls; 4 = protoconch width; 5 = last whorl width; 6 = umbilicus width; 7 = number of ribs on 1st teleconch whorl; 8 = number of ribs on last teleconch whorl.

Locality		Shell parameters							
		1	2	3	4	5	6	7	8
1	Pelorus Sound	5.1	2.8	5.0	1.0	0.9	1.1	46	87
2	Pelorus Sound	4.8	2.5	4.8	1.1	0.9	1.0	35	78
3	Havelock	5.7	3.9	5.3	1.0	0.9	1.0	35	76
4	Wainuiomata	6.6	4.0	5.1	1.4	1.1	2.2	35	76
5	Rimutaka S.F.	5.6	3.2	5.0	1.2	1.0	1.0	30	75
6	Taihape	7.3	4.5	4.8	1.1	1.1	1.5	43	92

1, 2. AK151515, P26 752147, J.F. Goulstone 14/2/96. 3. AK151408, P27 739916, J.F. Goulstone 15/2/96. 4. AK155518, R27 734909 100 m, J.F. Goulstone 17/10/98. 5. AK155516, R27712824 100 m, J.F. Goulstone 17/10/98. 6. AK155638, T21 498665 396 m, P.C. Mayhill 1/12/98.

DISTRIBUTION AND HABITAT

Phenacohelix lucetta reaches its northern limit in coastal Bay of Plenty, North Island, and extends southward to the Marlborough Sounds and Nelson areas in the South Island. It is commonly found with *Charopa coma*, particularly under loose bark on fallen logs, or under logs or branches on the ground. It was found in large numbers, together with *Charopa coma*, under flax (*Phormium tenax*) and tree fern (*Cyathea* or *Dicksonia* spp.) at the Belmont Regional Park in Wellington (Hazelwood, Marston & Roscoe 24/5/99, AK-L22226).

Phenacohelix mahlfeldae n. sp.

Figs 6, 12

Phenacohelix pilula: Suter (1913), Cumber (1961) and Powell (1979); not of Reeve (1852).

ETYMOLOGY

Named for Karin Mahlfeld.

DESCRIPTION

Shell

Small (3.2 mm x 2.6 mm), globose, perforate, four and a half whorls, final whorl 0.7 mm wide. Protoconch 0.7 mm wide, 1.5 whorls, with fine pits and ridges. Aperture 0.6 of shell height. Teleoconch whorls with close, strong, rounded, primary axials, 40 on first whorl, 72 on last. Axials angled backwards from suture but quickly straightening and only slightly undulating

Fig. 5 (opposite). Anatomy of *Phenacohelix lucetta* (Hutton). Scale lines = 1 mm (A, E) or 0.5 mm (B, C, D, F). A-D, F. AK15151, Pelorus Sound. E. AK155638, Taihape. A. Pallial organs, ventral view. B. Position of oesophagus entering buccal mass. C. Posterior portion of foot. D. Ovotestis and expanded portion of hermaphrodite duct. E. Terminal genitalia. F. Reproductive organs. For key to abbreviations, see Fig. 1.

over perimeter into umbilicus. Interstices between primary axials (up to 0.1 mm wide) have up to 12 fine secondary axials. Whole teleoconch surface has microscopic spiral lirae. Umbilicus narrow (0.2 mm). Shell strongly coloured with bands and zigzags of reddish brown 5YR/4/4, on background of very pale brown 10YR/8/2. Sometimes zigzags on base fused together to form solid ring of reddish brown around umbilicus.

External Morphology
Whole animal, fully extended (less ommatophores), 4.7 mm long. Colour white, with a light grey strip along mantle collar and around respiratory pore. Ommataphoral retractor muscles light grey. Foot margin strongly crenellated, as is narrow space between two pedal grooves. Tail with shallow foss. Dorsal aspect of tail immediately behind mantle (0.6 mm) with shallow, transverse grooves, but posterior 0.4 mm becomes strongly crenellated.

Reproductive Anatomy
Ovotestis embedded in digestive gland, comprising two clumps of 3-4 long, finger-like alveoli, each 0.32 mm long. Hermaphrodite duct initially very slender, then expands 3-4-fold and becomes convoluted for almost whole length of stomach against which it rests. Crossing the lower reaches of the oesophagus, the hermaphrodite duct abruptly reduces in diameter and enters albumen gland. Details of carrefour and talon were not determined. Albumen gland (1.6 mm long) consists of very closely packed, small alveoli. Spermoviduct (1.75 mm long) ovoid, coarse prostatic alveoli in proximal half. Free oviduct (1.1 mm long) a thick, stout tube. Spermathecal duct narrow at origin, but expands rapidly into ovoid section whose lumen is reduced to a narrow Y-shaped gap by three broad, longitudinal ridges. Spermethecal duct then tapering, but still substantial, to reach a spherical sac (0.4 mm diameter) that rests against the albumen gland. Vagina very short in young specimen, absent in older one. Vas deferens arises from distal spermoviduct as moderately wide tube, then abruptly becomes slender to pass forward through angle between free oviduct and penis, to enter the epiphallus. Epiphallus 1.9 mm long, tubular, of uniform width throughout, thin-walled, opening slightly below the penial apex. Penis 2 mm long, elongated, pear shaped proximally, then simple short tube, distally, leading to atrium. Lumen of penis evidently smooth expect for a large, oval block of fused, pillar-like pilasters protruding from wall in lower proximal section; in younger specimens the individual pilasters were not visible. Penis retractor muscle arising from the diaphragm at base of the kidney.

Other Anatomy
Pallial cavity 4.7 mm long, with a mixture of black and white pigment spots on the upper membrane. Kidney has large pericardial lobe (2.3 mm long), with heart (0.8 mm long) embedded in its right, somewhat crenellated margin; rectal lobe weakly developed, rounded. Ureter arises near anterior tip of kidney pericardial lobe, passes along anterior face of that lobe, turns forward along short rectal lobe, and follows hindgut to open through respiratory pore. Roof of pallial cavity visible between two arms of ureter. Stomach (2.5 mm long) has many strands of stringy

Fig. 6 (opposite). Shell and anatomy of *Phenacohelix mahlfeldae* n. sp. Scale lines = 1 mm (A-C, F, H) or 0.5 mm (D, E, G). A. Shell of holotype, AK73174. B. Shell showing band of red on ventral surface. C. Pallial organs, ventral view. D. Posterior part of foot. E. Reproductive anatomy. F. Hermaphrodite gland and duct. G. Part of terminal reproductive anatomy. H. Anterior of foot with pedal ganglia and pedal mucous gland. For key to abbreviations, see Fig. 1.

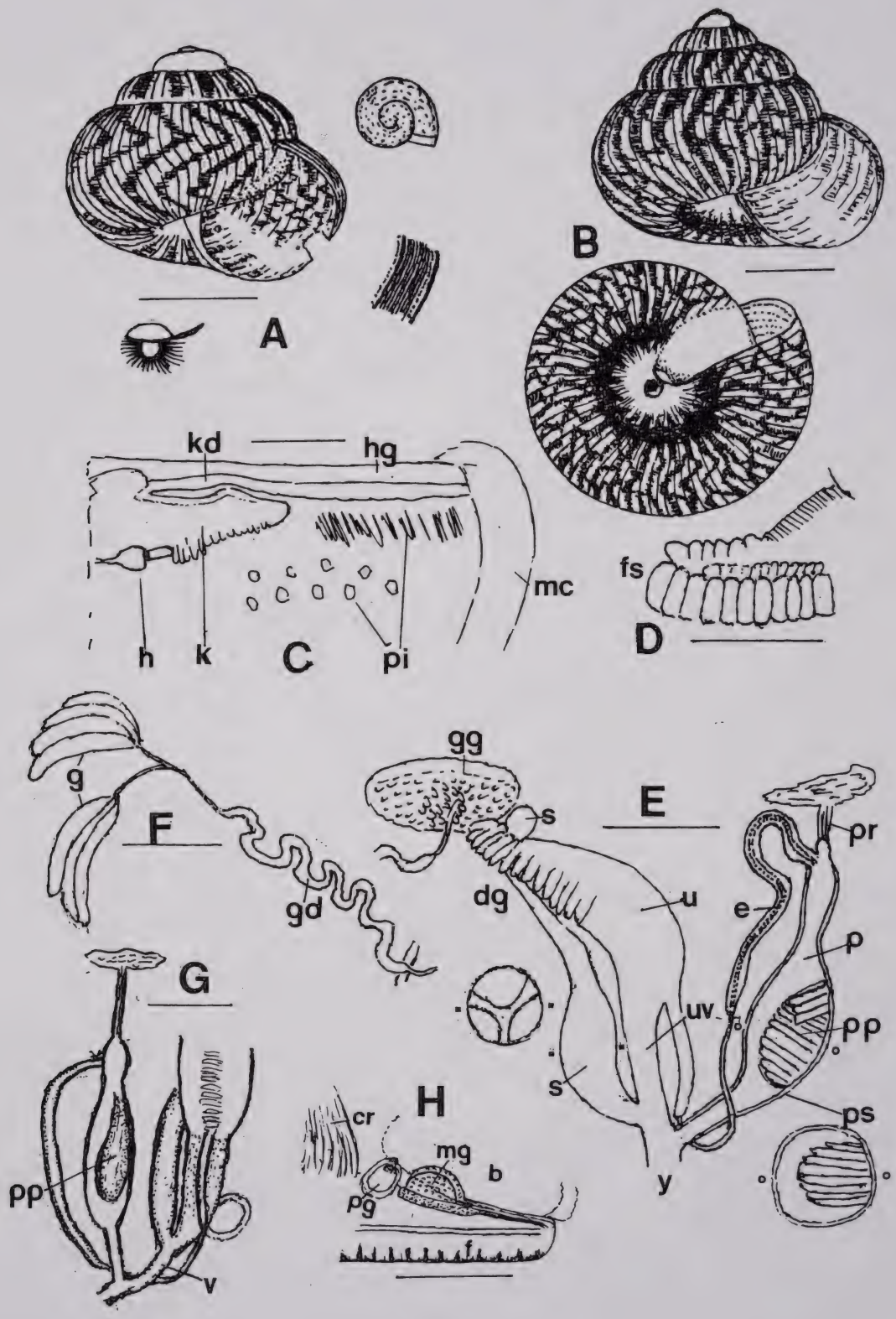
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Table 5. Structural features of the shell of *Phenacohelix mahlfeldae* n. sp. based on measurements taken from representative shells of adults from selected localities. Shell parameters: 1 = width; 2 = height; 3 = whorls; 4 = protoconch width; 5 = last whorl width; 6 = umbilicus width; 7 = number of ribs on 1st teleconch whorl; 8 = number of ribs on last teleconch whorl.

Locality	Shell parameters							
	1	2	3	4	5	6	7	8
1 Tahakopa Sc. Res.	3.2	2.6	4.5	0.7	0.7	0.2	40	72
2 Tahakopa Sc. Res.	3.0	2.5	4.5	0.7	0.7	0.2	37	68

1. AK155159. 2. AK155654. Both Catlins, South Otago, G47 295005 10 m, P.C. Mayhill 1/4/98.

white pigment over surface. The pedal ganglia, lying beneath the buccal mass, each have a brightly white statocyst on the dorsal surface. Just forward of the pedal ganglia, two mucous glands empty below the mouth via small ducts.

REMARKS

The shell and anatomical descriptions given above are for the two dissected specimens, from Tahakopa Scenic Reserve, South Otago (Table 5). Further material from this site, suitable as types, was not available. A shell specimen from Dolomore Park, Southland, was selected as the holotype. Despite the geographic distance from Tahakopa, this choice seemed preferable to using the plentiful but as yet anatomically unknown Stewart Island material.

Although the shell of *P. mahlfeldae* n. sp. looks superficially like *P. pilula*, closer inspection reveals many differences. For example, *P. mahlfeldae* possess a smaller, more globose shell, which is more highly coloured, and with different protoconch sculpture. This is an uncommon snail in the south of the South Island but is more abundant on Stewart Island. *P. mahlfeldae* is well represented in subfossil deposits on Native Island.

TYPE LOCALITY

Southland, Croydon Bush, Dolomore Park F45 871527 210 m.

HOLOTYPE

AK73174, 2.3 mm x 1.9 mm, P.C. Mayhill 1/1/94. Other shell dimensions: protoconch 0.6 mm; last whorl 0.6 mm; aperture height 1.2 mm; umbilicus 0.2 mm; primary axials on first teleoconch whorl 30, on final whorl 46.

PARATYPES

AK 73175 (4) Hokonui Range, Croydon Bush, kahikatea litter, F45 910527 J.F. Goulstone 22/2/95. MONZ 127645 (1) Purakaunui Falls Sc. Res. G47 456045 110 m K. Mahlfeld and P.C. Mayhill 12/4/98.

OTHER MATERIAL EXAMINED

SUBFOSSIL: Port Craig, Sandhill Point C46 721243, F.J. Brook 15/12/87, AK96709. **Native Is., Stewart Is.** E48, L. Fitzgerald 1/1/69, AK82998, E48, J.F. Goulstone 1/1/74, AK150170.

RECENT: Diamond Lake F40 897120 400 m, P.C. Mayhill 1/1/96, AK155924. **Whakatipu, Bobs Cove** F41 578609 360, P.C. Mayhill 1/1/89, AK155720. **Kingston, Te Kea Haka Reserve** F42 738335, J.F. Goulstone 9/3/98, AK154790; F42 746347 460 m, P.C. Mayhill 1/1/89, AK155704. **Wye Creek** F42 774577 420 m, P.C. Mayhill 1/6/89, AK155940. **Te Anau, Brod Bay** D43 928205, J.F. Goulstone

1/1/76, AK83016. **Blue Mountains, Black Gully** G44 265731, J.F. Goulstone 21/2/95, AK96544. **Taieri Gorge** I44 956089, J.F. Goulstone 1/1/91, AK155653. **Blue Mountains, Glenburnie Scenic Reserve** G45 213585, J.F. Goulstone 12/2/95, AK97007. **Waiau River, Big Totara Reserve** D45 937687, J.F. Goulstone 26/2/95, AK97029. **Clifden** D45 999494, J.F. Goulstone 25/2/95, AK96593. **Tapanui, Whisky Gully** G45 225657, P.C. Mayhill 1/1/99, AK155690. **Pahia Hill Scenic Reserve** D46 025187, J.F. Goulstone 20/2/95, AK150379. **Forest Hill** E46 573354 180 m, P.C. Mayhill 1/9/83, AK155938, E46 574354 180 m, P.C. Mayhill 1/9/83, AK155939. **Egremont Rd.** F46 073185 320 m, P.C. Mayhill 1/1/94, AK155941. **Catlins, Samsons Hill** G47 253954 200 m, P.C. Mayhill 1/1/94, AK155248. **Halfmoon Bay** E48, E. Smith 1/5/49, AK83012. **Fishermens Rock Pt.** E48 407573, N. Douglas 1/5/71, AK153199. **Road to Golden Bay** E48, E. Smith, AK82995. **Behind woolshed** E48, E. Smith 1/6/49, AK82996. **Ulva Is.** E 48, A.E.Brookes, AK82981. **Maori Bay, east end** E48 353612, J.F. Goulstone 1/1/74, AK150166. **Lords River** E49 401350 20 m, N. Douglas 10/5/71, AK153189.

DISTRIBUTION AND HABITAT

The species is present in South Otago, Southland and Stewart Island. The two Catlin specimens dissected were found in bush on the ground, crawling on sticks 2-3 cm in diameter. The Whiskey Gully specimen was collected from under a stone.

Phenacohelix perplexa (Murdoch, 1897)

Figs 7, 12

DESCRIPTION

External Morphology

Foot sole thin, white, its margin weakly crenellated and surmounted by two pedal grooves. Posterior section of sole smooth. Dorsal surface of tail smooth, flecked with grey-black, tip of tail white.

Reproductive Anatomy

Ovotestis has two crowded clumps of finger-like alveoli, each 1 mm wide, embedded in digestive gland close to stomach apex. Hermaphrodite duct initially very slender, but for most of its length (2.5 mm) distended as seminal vesicle (0.3 mm wide), before reducing in diameter to terminate in the carrefour embedded in the albumen gland. Talon not detected. Albumen gland variable in size, but generally small (up to 1.2 mm); consisting of very small, crowded alveoli. Spermoviduct (2.9 mm long) tubular, narrow but for weak globular dilation in middle section. Free oviduct (1.3 mm long) slightly narrower tube than distal section of the spermoviduct. Spermathecal duct narrowed at opening to free oviduct, but expanding three-fold in width to produce a prominent, ovoid basal section with low, wavy internal ridges, then narrowing abruptly to run to large, ovoid sac (up to 1.4 mm long) that rests between albumen gland and columellar muscle. Vagina short (0.4 mm long), about same width as free oviduct. Vas deferens slender throughout passage through angle of vagina and penis close to the male genitalia. Epiphallus short, stout (0.6 mm long x 0.15 mm wide), slightly arched, opening at apex of the penis adjacent to the penial retractor. Penis consists of a small upper or proximal chamber, a large middle chamber which can be globular or produced laterally as an indistinct caecum, and a distal tube, reducing to same width as vagina where they meet in atrium. Internally, penis with short papilla, produced initially as an array around opening of the epiphallus, then produced into low ridges and folds in the proximal and middle chambers. Wall of middle chamber greatly thickened as a large, bulky pilaster, cover with papillae, and extending into the caecal pocket. Distal penis initially possesses several low ridges. Penial retractor muscle is anchored to the diaphragm, close to base of the kidney.

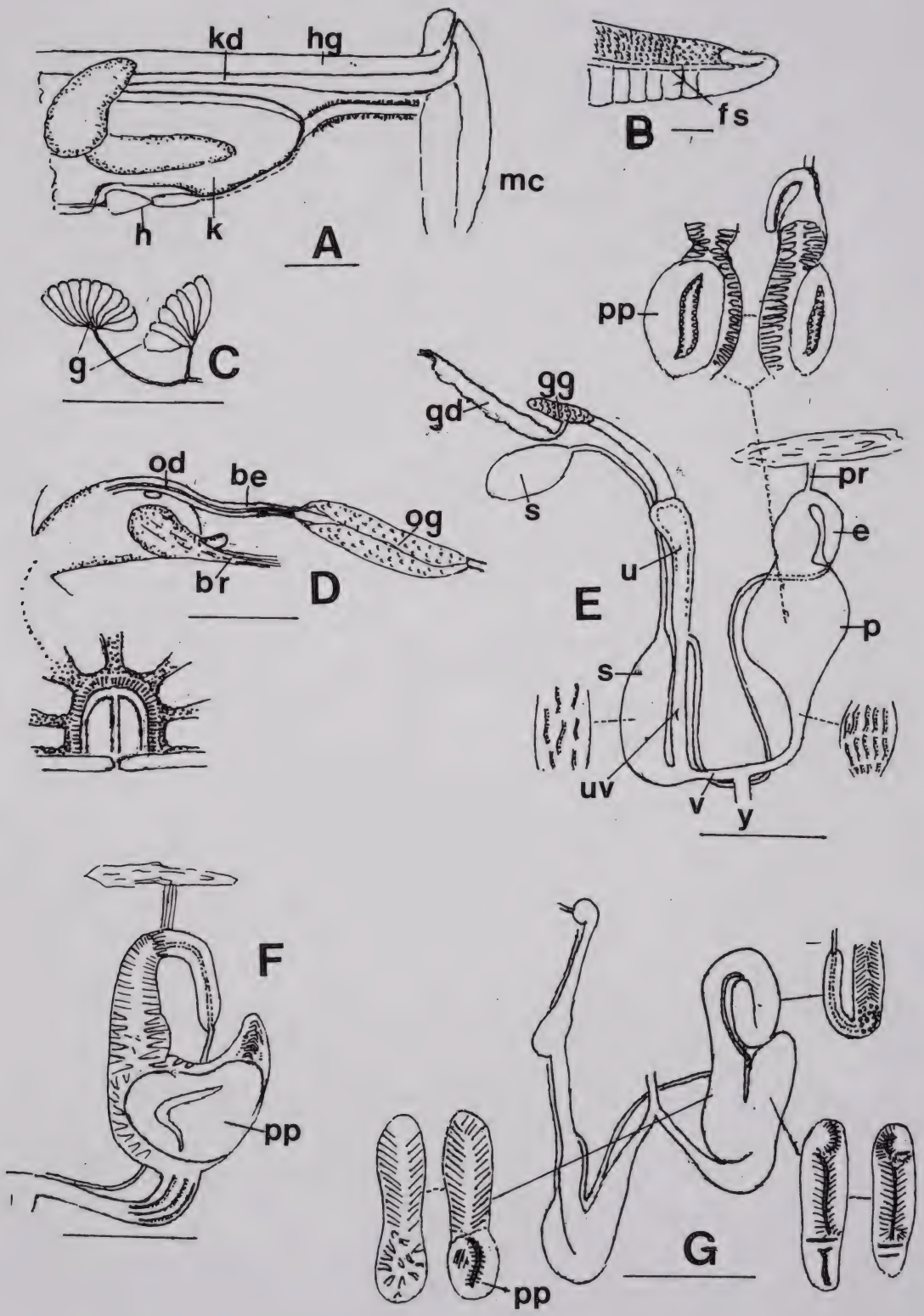
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Table 6. Structural features of the shell of *Phenacohelix perplexa* (Murdoch, 1897) based on measurements taken from representative shells of adults from selected localities. Shell parameters: 1 = width; 2 = height; 3 = whorls; 4 = protoconch width; 5 = last whorl width; 6 = umbilicus width; 7 = number of ribs on 1st teleconch whorl; 8 = number of ribs on last teleconch whorl.

Locality	Shell parameters							
	1	2	3	4	5	6	7	8
1 Waenga	6.3	4.3	4.8	1.3	1.8	0.9	37	81
2 Papatea	5.6	4.2	4.5	1.3	1.6	0.7	38	83
3 Gordon Park	6.9	4.2	4.5	1.3	1.6	1.2	46	142
4 Gordon Park	6.9	4.2	4.3	1.3	1.8	1.1	40	121

1. AK154596, Y14 652913 140 m, G.M. Barker 16/9/92. 2. AK154589, Y14 385806 100 m, G.M. Barker 14/9/92. 3, 4. AK155523, R22 895415 30 m, J.F. Goulstone 15/10/98.

Other Anatomy

Pallial cavity 6.2 mm long, with much black pigment over the outer membrane. This black pigmentation also extending over the rest of the animal. Mantle collar 1.2 mm wide. Kidney large (4.1 mm long). Ureter passes from apex of the kidney along anterior face of the pericardial lobe, then turns forward along face of rectal lobe and thence following hindgut to open through the respiratory pore. Roof of pallial cavity visible between two arms of the ureter. Heart (1.5 mm long) recessed into kidney, with main pulmonary vein prominent in anterior of the pallial cavity. Oesophagus, flanked by the salivary ducts, enters roof of the buccal mass near its median, dorsal point. Buccal retractor muscle attachment prominent on posterior half of buccal mass. Pedal ganglia situated under the buccal mass, each with a statocyst, as glistening white spot, on their dorsal surface.

REMARKS

Four specimens were dissected, two from East Cape, two from Wanganui. One specimen, which had up to 1.1 mm of jelly-like material along the proximal and middle sections of the spermoviduct, also had the distal section of the spermoviduct somewhat enlarged and free oviduct shorter and wider. In only one specimen was there evidence of prostatic alveoli on the proximal spermoviduct, and they were very weakly developed. The penis of all dissected specimens was essentially the same structure but varied in shape. The least sexually mature specimen had the most pronounced penial caecum, with the rudiments of a pilaster. In the most developed specimen the caecum was barely discernable. It may be that the younger snails start with a fully developed penial caecum, and that this structure is partly or wholly lost with age. I did not observe any differences between the material from East Cape and Wanganui. Table 6 gives measurements for this species.

Fig. 7 (opposite). Anatomy of *Phenacohelix perplexa* (Murdoch). Scale lines = 1 mm. A-E. AK15523, Gordon Park. F. AK154589, Papatea. G. AK154596, Waenga. A. Pallial organs, ventral view. B. Posterior portion of foot. C. Ovotestis. D. Buccal mass, showing oesophagus entry and enlarged view of mouth parts. E. Reproductive organs. F. Penis from another specimen showing enlarged internal pilaster. G. Reproductive organs from a younger specimen showing pilaster in early stages. For key to abbreviations, see Fig. 1.

DISTRIBUTION AND HABITAT

Specimens held in the Auckland Museum suggest that *P. perplexa* has a disjunct distribution, being confined to around East Cape and around Wanganui. However, material in the Museum of New Zealand includes specimens from intermediate localities (F.M. Climo pers. comm.), pointing to a more generalised distribution in the central North Island. The specimens I collected from around Wanganui were all on the undersides of logs on the ground.

Phenacohelix pilula (Reeve, 1852)

Figs 8, 12

DESCRIPTION

External Morphology

Foot margin weakly but finely crenellated. Two pedal grooves, with crenellations between them, end posteriorly in a caudal foss surmounted by a caudal horn. Dorsal surface of tail grey, with shallow segmented grooves.

Reproductive Anatomy

Ovotestis (1.2 mm x 0.9 mm) consists of two clumps of finger-like alveoli embedded in digestive gland tissue. Hermaphrodite duct initially slender, but soon becomes distended to a sickle-shaped seminal vesicle (0.3 mm wide), then reduces to a short, slender section to terminate in the carrefour on ventral aspect of the albumen gland. Talon spherical, on a short stalk. Albumen gland (up to 2.3 mm long) ovoid, consisting of dense, minute alveoli. Spermoviduct oblong (2.0 mm long x 0.6 wide), with prostatic alveoli along whole length but more concentrated and prominent proximally. Free oviduct variable in length and width, proximal half generally narrower (0.15 mm wide) than distal half, the latter tends to be bulbous; lumen uniform diameter throughout its length. Spermathecal duct broad at origin in oviduct, usually wider than distal section of free oviduct, but tapers steadily to terminate in an oval sac (0.4 mm long) buried in prostatic alveoli close to the albumen gland; base of duct has internally several flap-like ridges leading from vagina. Vagina (1.0 mm long) tapers from union with spermathecal duct and oviduct, towards atrium, but is sometimes distended medially. Vas deferens slender throughout, enters penis a little below the latter's apex. Penial retractor muscle has its origin in the diaphragm near the base of the kidney, and inserts on the apex of the penis. Penis (3.4 mm long) comprises two chambers, separated by a restriction of the outer wall, and a distal tube of variable length leading to the atrium. The proximal chamber has thick walls, internally covered with crowded papillae, leaving only a small central passage. The second penial chamber is similarly lined with papillae, for a large part forming low ridges orientated towards toward the opening of penial caecum arising from the upper lateral wall. Penial caecum wide (0.3 mm),

Fig. 8 (opposite). Shell and anatomy of *Phenacohelix pilula* (Reeve). Scale lines = 1 mm (A, B, E-G) or 0.5 mm (C, D). A. Reconstructed drawing taken from photo of holotype, scale produced from Suter=s type measurements. B. Shell from Port Waikato, AK155671. C. Reproductive anatomy of specimen from Mill Bay, Coromandel; other cross-section of proximal penis from a similar specimen from same location. D. Ovotestis and hermaphrodite duct. E. Pallial organs, ventral view. F. Reproductive anatomy of a younger specimen from Port Waikato. G. Reproductive anatomy of a specimen from Mimiwhangata with lumen features changed in distal chamber of penis, free oviduct and base of spermathecal duct. For key to abbreviations, see Fig. 1.

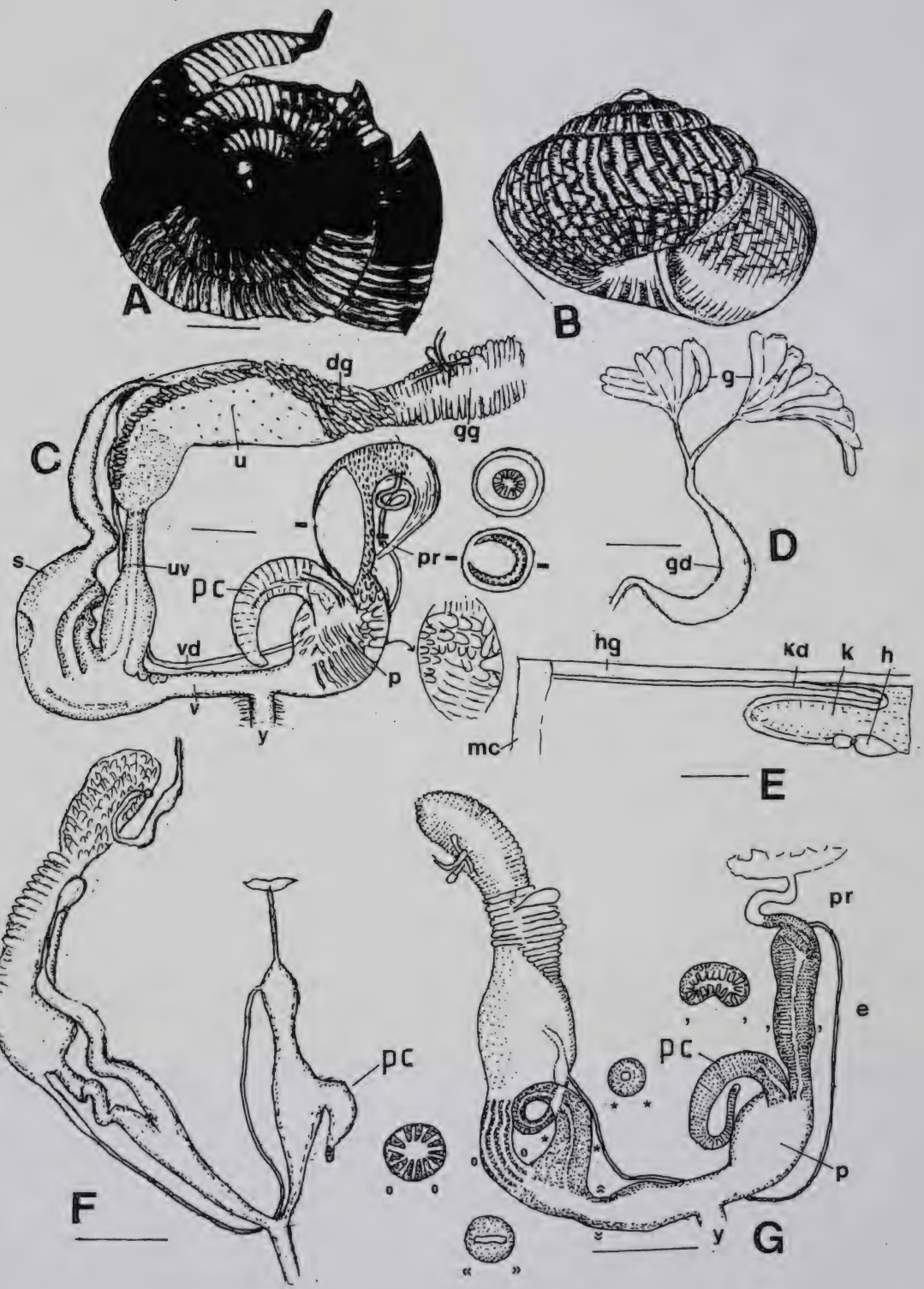
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Table 7. Structural features of the shell of *Phenacohelix pilula* (Reeve, 1852) based on measurements taken from representative shells of adults from selected localities. Shell parameters: 1 = width; 2 = height; 3 = whorls; 4 = protoconch width; 5 = last whorl width; 6 = umbilicus width; 7 = number of ribs on 1st teleconch whorl; 8 = number of ribs on last teleconch whorl.

Locality		Shell parameters							
		1	2	3	4	5	6	7	8
1	Whangaroa	4.2	3.4	4.8	0.8	0.9	0.3	34	72
2	Waiwera	3.2	2.7	4.3	0.7	0.5	0.2	36	66
3	Umupia Reg Park	2.9	2.4	4.0	0.7	0.8	0.2	36	58
4	Mill Creek	3.1	2.1	3.8	0.5	0.9	0.3		
5	Mill Creek	3.1	2.1	3.8	0.9	0.9	0.3		
6	Tuahu Tr., Kaimai	5.7	3.6	5.0	0.9	1.5	1.0	40	94
7	Lake Tarawera	5.7	3.8	4.8	1.5	1.6	0.9	40	100
8	Port Waikato	3.7	2.5	4.2	0.7	0.9	0.3	31	66

1. AK155211, P04 788826, B.F. Hazelwood 24/5/98. 2. AK96820, J.F. Goulstone 14/4/95. 3. AK154012, S11 955747, J.F. Goulstone 26/11/95. 4, 5. AK80615, T11 766473 J.F. Goulstone 1/4/83. 6. AK154567, T14 624961 400 m, P.C. Mayhill 1/4/97. 7. AK154622, U16 056273 304 m, G.M. Barker 1/1/80. 8. AK155250, R13 684277 60 m, B.F. Hazelwood 22/6/98.

thick-walled and with very narrow opening where it joins penis, but reduces to a more saccular structure, with blunt, often recurved, tip and thin, transparent walls strengthened by close concentric rings.

Other Anatomy

Pallial cavity 6 mm long, with heavy black pigment on roof. Kidney has long, ovoid pericardial lobe (2.5 mm long) with heart (0.8 mm long) recessed, and a weak, slender rectal lobe. Ureter starts at kidney apex, passes along anterior face of pericardial and rectal lobes and then along hindgut to open through respiratory pore. Roof of pallial cavity can be seen between adjacent arms of the ureter. Oesophagus, with flanking salivary ducts, joins roof of buccal mass near its median dorsal point. Glistening white statocysts are visible on the dorsal surface of the pedal ganglia situated under the buccal mass.

REMARKS

Cumber (1961) evidently only studied true *P. pilula*, collected by him from the north of the South Island. Although he published Suter's distribution list and included the southern South Island records in a distribution map, he may never have seen the southern material. It is thus possible that Cumber's southern records of '*pilula*' actually pertain to *P. mahlfeldae*.

Eight specimens of *P. pilula* were dissected in the present study (Table 7). A specimen from Mill Bay, Whitianga, had what appeared to be a large, fleshy pilaster in the proximal penial chamber. However, the second specimen for that locality had thick walls and a circular central channel (Fig. 8C). A specimen from Mimiwhangata had the lower chamber of the penis devoid of any internal papillae, the free oviduct with many internal, plate-like ridges, and with the base of the spermathecal duct thick-walled with a simple, narrow lumen.

DISTRIBUTION AND HABITAT

Phenacohelix pilula is wide ranging in the North Island, although absent from the Far North. It

has been collected frequently in the Nelson and Marlborough Sounds areas, and more sparingly in Canterbury and Otago. *P. pilula* is evidently absent from the West Coast or Southland regions. In the Taieri Gorge, *P. pilula* is sympatric with *P. mahlfeldae* (AK83003). Live specimens are most often collected from forest leaf litter, but have also been collected as they crawl on the fronds of low-growing ferns.

Phenacohelix ponsonbyi (Suter, 1897)

Figs 9, 12

DESCRIPTION

Shell

Small (5.5 mm x 3.7 mm), depressed globose. Whorls, four and a half in mature animals, are flatly rounded, final whorl 1.5 mm wide. Aperture 2.4 mm high x 2.8 mm wide. Protoconch 0.9 mm wide, of 1.1 whorls, with close, spiral lirae. Teleoconch whorls have closely-spaced primary axials, arising from a shallow suture and sloping gently away from direction of shell growth on dorsal surface, sinuous on ventral surface into the umbilicus. Axials numbering 43 on first teleoconch whorl, and 114 on final whorl, are each slightly rounded at apex. Interstices have fine, crowded secondary axials (up to 14). Microscopic spiral sculpture hardly noticeable (up to 60x magnification). Umbilicus 1.4 mm wide. Colour is very pale brown 10YR/83, superimposed with reddish brown 5YR/4/4 flashes and zigzags.

External Morphology

Foot margin crenellated, with two pedal grooves above that terminate posteriorly in a slight depression at the tail. Narrow space between pedal grooves also crenellated. Dorsal surface of tail has close shallow horizontal grooves up to mantle collar.

Reproductive Anatomy

Ovotestis, embedded within the digestive gland tissue, comprises two pyramid-like clusters of alveoli. Hermaphrodite duct initially very slender, then expands in diameter four fold to run for 2.3 mm as the seminal vesicle, before again reducing to enter carrefour partially embedded in albumen gland. Carrefour complex carries an oblong talon, 0.2 mm long. Albumen gland (2.3 mm long) comprises closely crowded alveoli, narrows (0.3 mm wide) where it joins spermoviduct. Spermoviduct elongate, oval, with thick finger-like prostatic alveoli as band along proximal two thirds. Free oviduct a long tube (1.6 mm long x 0.3 mm wide), expanding slightly at entry into vagina, where its lumen bears longitudinal folds. Spermathecal duct expands from origin into ovoid basal section (base 1.4 mm long), then reduces to fine tube that terminates in an oval sac (0.5 mm long) resting against albumen gland; lumen of spermathecal base with longitudinal ridges. Vagina short, slightly globular, with internal, crowded, fine circular ridges. Vas deferens arises from distal spermoviduct as tube of similar width and length as free oviduct, but then abruptly reduces to fine tube passing through angle of penis and vagina close to atrium and enters penis somewhat below apex. Epiphallus evidently absent. Penis retractor muscle arises from diaphragm membrane about half way along pallial cavity, attached to penis apically. Penis (2.8 mm long) comprises three sections: a bulky, weakly ovoid proximal section (1.1 mm wide); a bulky, weakly ovoid middle section; and a narrow, short, tapering distal section (0.4 mm wide) opening to the atrium—proximal and middle sections often separated by slight constriction. Internally the proximal penis is completely covered in short papillae, the middle section possesses a number of low, horizontal ridges, and the distal section is evidently

smooth. Opening to the upper part of the middle penial section, and curled towards the atrium, is a penial caecum, comprising essentially a thin-walled tube strengthened by concentric ridges, half the length of the penis, broadest where it joins the penis and reducing in width to terminate in narrow tail curled back on itself. A narrow orifice connects this organ with the penis.

Other Anatomy
Pallial cavity (5 mm long) has blotches of black and white pigment on its outer membrane. Kidney pericardial lobe large (2.3 mm long), with the pericardium (1.1 mm long) impressed into its outer wall. Rectal lobe rather small. Ureter passing from apex of pericardium lobe, along anterior face of the kidney, to angle with short rectal lobe, then following hindgut to exit through respiratory pore. A wide gap exists between the primary and secondary arms of the ureter. Oesophagus, and flanking salivary ducts, enter roof of buccal mass near median dorsal point. Pedal ganglia evidently fused, with glistening white statocysts on their dorsal surface.

REMARKS
The type locality of *Phenacohelix ponsonbyi* is the Mt Wellington lava fields, Auckland. The type locality has been virtually lost to urbanisation, with the area largely covered in houses and factories. No forest cover remains. At the time of writing (August 1998), B.F. Hazelwood could find only one empty *P. ponsonbyi* shell at R11 726758, where 20 years ago the species was still abundant. This site is to be developed as a quarry but is presently covered with exotic weeds and litter.

Cumber (1961) determined that the *P. ponsonbyi* (Suter) of most authors subsequent to Suter (1897) comprised two forms separable on shell characters. Cumber chose plesiotypes from the Waikato to more properly represent the dominant form. That dominant form is formally described in the present paper as *Phenacohelix hakarimata* n. sp. (see below).

I have redescribed the shell of *P. ponsonbyi* because Cumber's description encompasses the two species. The shell description and illustration given in the present paper are of a typical topotype specimen from the Mt Wellington lava fields (AK83085 R11 726758, Mrs D. Hole 29/8/76). The colour is taken from a fresh specimen. Cumber has adequately described the lectotype and I repeat his measurements below. The flatness of the dorsal surface with attendant shallow suture and raised protoconch, accelerated final whorl, wider umbilicus and slightly larger mature shells, distinguish *P. ponsonbyi* from *P. hakarimata* n. sp. I dissected five specimens, all from Auckland, the shell measurements of which are given in Table 8.

TYPE LOCALITY
Mt Wellington lava fields, Auckland.

LECTOTYPE
MONZ 125160, 5.25 mm x 3 mm, umbilicus 0.9 mm, ribs on first teleoconch whorl 36, third teleoconch whorl 82. Measurements from Cumber (1961).

Fig. 9 (opposite). Shell and anatomy of *Phenacohelix ponsonbyi* (Suter). Scale lines = 1 mm. A. AK83085, Mt Wellington. B-E. AK155252, Cosseys Dam 1. A. Shell. B. Posterior portion of foot. C. Ovotestis and hermaphrodite duct. D. Pallial organs, ventral view. E. Reproductive organs. For key to abbreviations, see Fig. 1.

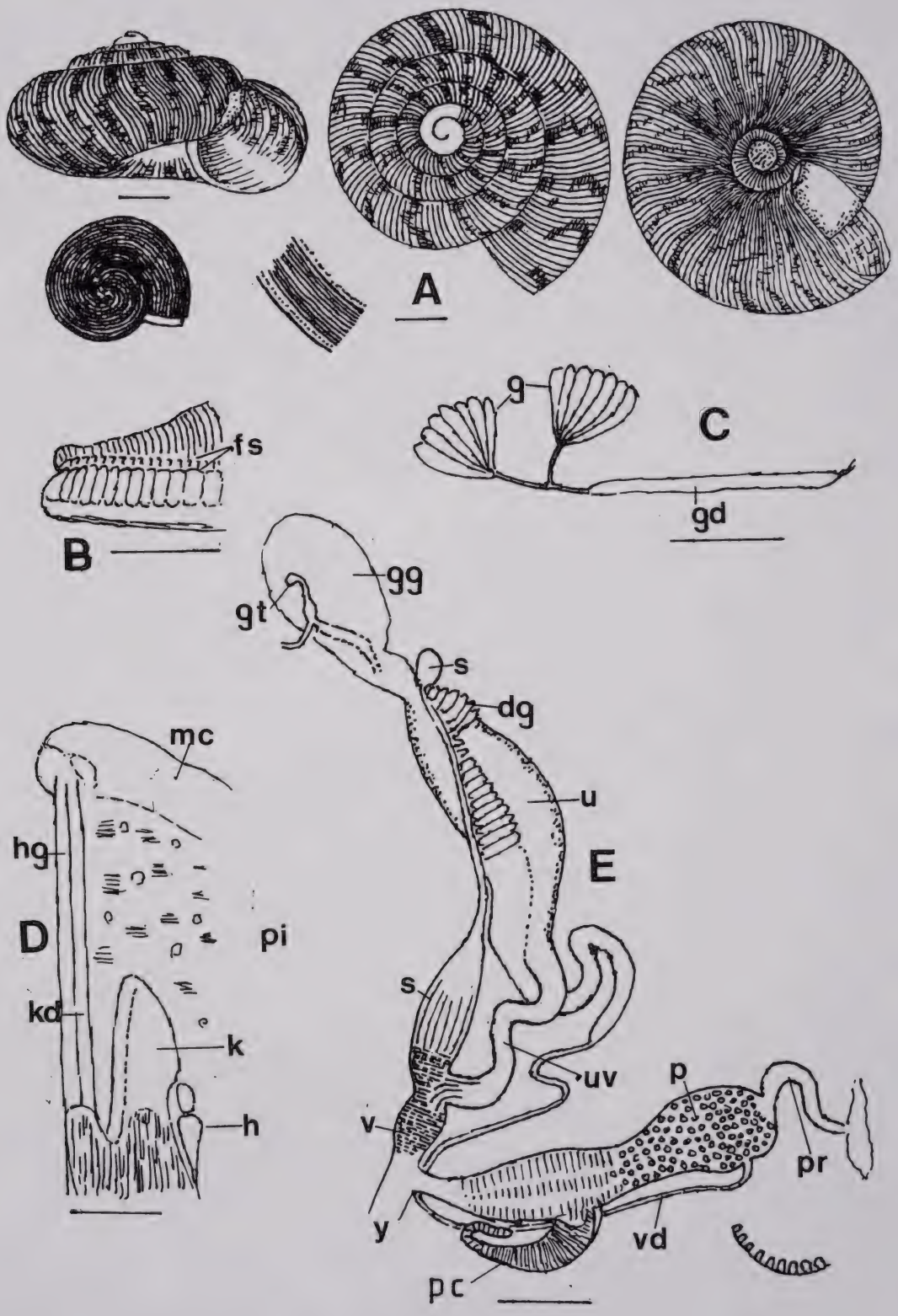
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Table 8. Structural features of the shell of *Phenacohelix ponsonbyi* (Suter, 1897) based on measurements taken from representative shells of adults from selected localities. Shell parameters: 1 = width; 2 = height; 3 = whorls; 4 = protoconch width; 5 = last whorl width; 6 = umbilicus width; 7 = number of ribs on 1st teleconch whorl; 8 = number of ribs on last teleconch whorl.

Locality		Shell parameters							
		1	2	3	4	5	6	7	8
1	Cosseys Dam	5.3	3.0	4.5	0.8	1.6	1.0	36	86
2	Cosseys Dam	5.2	3.1	4.3	0.9	1.5	0.9	36	89
3	Cosseys Dam	5.3	3.1	4.5	0.9	1.5	0.9	39	97
4	Twighlight Rd.	5.6	3.6	4.5	0.9	1.6	1.0	38	83
5	Mangere Mountain	5.8	3.5	4.5	0.9	1.7	1.0	35	95

1, 2, 3. AK155252. 4. AK150852. 5. AK155338. All collected J.F. Goulstone.

PARALECTOTYPES

MONZ 125159 (2), from type locality.

OTHER MATERIAL EXAMINED

Waiwera, Puhoi Hill R10, A.W.B. Powell 5/4/47, AK83075. **Muriwai, Korekore Pa Hill** Q11, A.W.B. Powell 1925, AK83074. **Government House** R11 680792, J.F. Goulstone 17/11/95, AK150531. **Clevedon, Twilight Rd.** R11 898667, J.F. Goulstone 7/2/98. **Mt Wellington lava fields** R11 726759, J.F. Goulstone 1/1/76, AK155217, B.F. Hazelwood 1/8/98, AK155367; 726758, D. Hole 29/8/76, AK83085; J.F. Goulstone 1/12/85, AK83086. **Mangere Mountain** R11 692709 50 m, J.F. Goulstone 4/8/98, AK155341. **Waiatarua** R11, AK83073. **Titirangi** R11, 30/10/26, AK83080. **Wiri stonefields** R11 743632, J.F. Goulstone 1/11/87, AK83076. **Hunua Gorge** R12 868570, J.F. Goulstone 1/5/89, AK155220. **Waiuku** R12, W.H. Webster, AK83072. **Cosseys Dam** S12 974578 230m, J.F. Goulstone 1/3/83, AK83087, 21/6/98 AK155237, 29/6/98 AK155251; S12 975582 210 m, P.C. Mayhill 1/8/78, AK156105. **Mt William** S12 903414 200 m, P.C. Mayhill 1/8/81, AK156094. **Mangatawhiri** S12 029497 140 m, P.C. Mayhill 1/1/78, AK156118. **Parakiwai** T12 616327 60 m, P.C. Mayhill 1/11/82, AK154100; T12 535516 180 m, P.C. Mayhill 1/9/79, AK156080. **Kaitarakihi** T12 479467 420 m, P.C. Mayhill 1/2/94, AK156103. **Waikaretu** R13 665045 20 m, P.C. Mayhill 1/9/77, AK155501. **Colebaker Ridge** R13670235 200 m, P.C. Mayhill 1/6/83, AK155549. **Tauhei Quarry** S13 174075 60 m, P.C. Mayhill 1/3/79, AK156122. **Four Brothers Scenic Reserve** S14 927728, P.C. Mayhill 1/7/83, AK155539. **Kawhia-Raglan** R15 737508 60 m, P.C. Mayhill 1/11/79, AK155510. **Maungakawa No. 1** T15 325686 200 m, P.C. Mayhill 1/3/85, AK155507. **Pirongia State Forest Park** R16 883388 360 m, P.C. Mayhill 1/10/83, AK155536. **Waipuna Reserve** R16 836113 396 m, G.M. Barker 29/3/77, AK154642. **Waitomo** S16, A.E. Brookes, AK83084; S16 945250 91 m, G.M. Barker 1/9/89, AK154636. **Mangaokewa** S16 996176 40 m, P.C. Mayhill 1/11/80, AK155418. **Ruakuri** S16 818249 260 m, P.C. Mayhill 1/5/84, AK155509. **Whareorino** R17 609078 340 m, P.C. Mayhill1/3/83, AK155508. **Aorangi Reserve** R17 599819 60 m, P.C. Mayhill 1/3/78, AK155415. **Awakino Gorge** R17 595819 60 m, A. Eagle 1/11/81, AK155497. **Pureora, Hurakia Block** S17 246840, J.F. Goulstone 1/4/82, AK150400. **Mt Messenger** Q18 487554 200 m, P.C. Mayhill 1/10/80, AK155479. **Mokau Scenic Reserve** R18 546762 40 m, P.C. Mayhill 1/9/86, AK155485; R18 546763 40 m, P.C. Mayhill 1/5/87, AK155472. **New Plymouth, Te Henui Walkway** P19 046374, J.F. Goulstone 1/12/88, AK150058. **New Plymouth** P19 064331 80 m, P.C. Mayhill 1/4/87. **New Plymouth, Brooklands** P19 037867, J.F. Goulstone 1/12/88, AK97935. **Wanganui, Bushy Park** R22 752545 200 m, P.C. Mayhill 1/8/97, AK155491.

DISTRIBUTION AND HABITAT

Phenacohelix ponsonbyi s. str. evidently has a narrow geographic range and never seems to be abundant. Shells referable to *P. ponsonbyi* have been found in low numbers (usually one or two per locality) in western districts from Auckland to as far south as Wanganui, with the largest collection from a site at Aorangi Reserve (7 specimens). One site on the East Coast, at Parakiwai (P.C. Mayhill), has also been registered. At Cosseys Dam, Hunua Ranges, which is the best site I found for *P. ponsonbyi*, the gorge below the dam is rocky, a characteristic common to most of the sites where it is plentiful. Snails here were present inside the stalks of rotting tree fern fronds, under bark of rotting trunks and in fallen nikau fronds. At Mangere Mountain and Wiri, *P. ponsonbyi* was living among scoria rocks with a covering of *Muehlenbeckia.* At Government House, Mt Eden, the species was found living among rocks under a canopy of shrubs and trees replicating the environment at the now defunct type locality.

Phenacohelix tholoides (Suter, 1907)

Figs 10, 12

DESCRIPTION

External Morphology

Foot white, its margin weakly crenellated and with two closely-spaced pedal grooves ending in caudal foss at the posterior. Caudal horn present but not pronounced. Dorsal surface of tail grey, with close shallow grooves.

Reproductive Anatomy

Ovotestis comprising two clumps of finger-like alveoli (0.6 mm wide), embedded in digestive gland tissue close to stomach apex. Hermaphrodite duct proximal section (0.4 mm) very slender, but becomes distended to a seminal vesicle (0.1 mm diameter x 1.6 mm long) before tapering to terminate in the carrefour embedded in the ventral face of the albumen gland. Talon oblong (0.15 mm long). Albumen gland (up to 2 mm long) ovoid, placed in loop of intestine, consists of minute, closely-packed alveoli. Spermoviduct (2.7 mm long), cylindrical, uniformly broad but for narrow (0.2 mm) section where it arises from the albumen gland. Prostatic gland alveoli evident as a narrow strip along full length of the spermoviduct. Free oviduct (1.8 mm long) variable in width (1.5-2.0 mm). Spermathecal duct with bulbous basal region, tapering rapidly to a slender duct that follows spermoviduct and terminates in an oval sac resting against the albumen gland in the vicinity of the pericardium; epithelium of the spermathecal duct basal region produced as longitudinal flaps that extend to the centre of luminal cavity. Vagina short and stout (0.3 mm x 1.5 mm). Vas deferens short, uniformly slender, soon giving rise to the epiphallus that comprises an elongate, spindle-shaped proximal section and a slender, convoluted distal section. The proximal section of the epiphallus sometimes coils back upon itself, and is united to middle region of penis by connective tissue; this evidently occurs very early in formation of reproductive organs but does not persist when the genitalia are fully formed. Epiphallus inserting subapically on penis. Retractor muscle, attached to apex of penis, a short, tapered stalk fastened to diaphragm near base of the kidney. Penis proper (1.8 mm long) consists of two parts of roughly equal length. The proximal penis is an oval chamber upon a narrowed tubular extension leading to the distal penis. Internally this proximal section has small spinate papillae or "thorns" in the apical cavity, an extensive cluster of elongate pilasters around the verge formed by entry of the epiphallus and, in the main lumen, with numerous large spinate papillae and a longitudinal row of paired small, spinate papillae. This paired row of spinate papillae

runs into the junction with the distal penis. Distal section of penis cylindrical, with lumen lined with four broad, smooth, longitudinal folds. Penial caecum arising from lateral wall of penis proper, at junction of proximal and distal sections, its lower reaches a cylindrical to bulbous chamber whose wall possesses spinate papillae similar to that in the proximal penis proper. A large, hollow dart (0.4 mm long) arises from the thickened apical wall of the caecum to project into the lumen; the dart is evidently expendable and is sometimes absent or broken. The dart is continued external to the caecum by a elongate, thin-walled, striated, glandular tube, which scribes a looping round the penis and is fastened at its apex by connective tissue and muscle strands to the caecal wall near its point of origin. Caecum firmly bound to the lower reaches of the proximal penis by many layers of strong fibrous material.

Other Anatomy

Pallial cavity 7.7 mm long, with scattered spots of black and white pigment on the outer membrane. Kidney 3.0 mm long, dominated by strong pericardial lobe, with heart (1.3 mm long) recessed on outer margin, and with an indistinct rectal lobe. Ureter along anterior face of pericardial lobe from apex to junction with rectal lobe, then turning forward along hindgut to open through respiratory pore slightly behind anus. Adult specimens had no gap between the ureter arms. Oesophagus, and flanking salivary ducts, enter posterior extremity of the buccal mass. Statocysts gleaming white, visible on dorsal surface of the pedal ganglia that are located under the buccal mass.

REMARKS

Ten specimens of *Phenacohelix tholoides* (Suter, 1907) were fully dissected (Table 9). An animal extracted from a shell less than 4 mm in diameter proved to be reproductively immature, but some additional animals extracted from shells over 4 mm were also under-developed. A specimen from Ngahau Bay (AK154067), of shell size 3 mm and without discernible genitalia, nevertheless had a very well developed hermaphrodite duct. A further specimen from Ngahau Bay (Fig. 10H) was without the bulbous body of the penial caecum. Southern specimens were collected from April to August and were sexually fully mature. Te Paki specimens were collected in November and December and were immature, suggesting a phenological cycle. Clearly a larger sample needs to be examined to establish the reproductive phenology of the species. I have illustrated some undeveloped penial lumina: Fig. 10F = specimen 3 in Table 9, Fig. 10G = specimen 5 in Table 9.

OTHER MATERIAL EXAMINED

SUBFOSSIL: Many shells from several well documented sites have been recovered from the sandhills of Cape Maria van Diemen, Herangi Hill and behind Te Werahi Beach by F.J. Brook and C. Laurenson, 1993-97. One central site, for example, is at M02 800473. Because of their proximity I list only registration numbers. AK85548, AK89363, AK91678, AK91680, AK91693, AK91711, AK91718, AK91754, AK91771, AK91781, AK91792, AK91821, AK91828, AK91847, AK92111, AK92149, AK92157, AK92170, AK99953, AK99966, AK99984, AK101153, AK131830, AK-L9203, AK-L21170. **Taupiri**

Fig. 10 (opposite). Anatomy of *Phenacohelix tholoides* (Suter). Scale lines = 1mm. A-E. AK154067, Ngahau Bay. F. AK155650, Mahurangi Pt. G. AK154354, Waitononi. H. AK152179, Ngahau Bay. A. Ovotestis. B. Reproductive organs. C. Buccal mass, showing entry of oesophagus. D. Pallial organs, ventral view. E. Posterior portion of foot. F. Undeveloped penis. G. Penis at earlier stage than F. H. Reproductive organs which have developed atypically. For key to abbreviations, see Fig. 1.

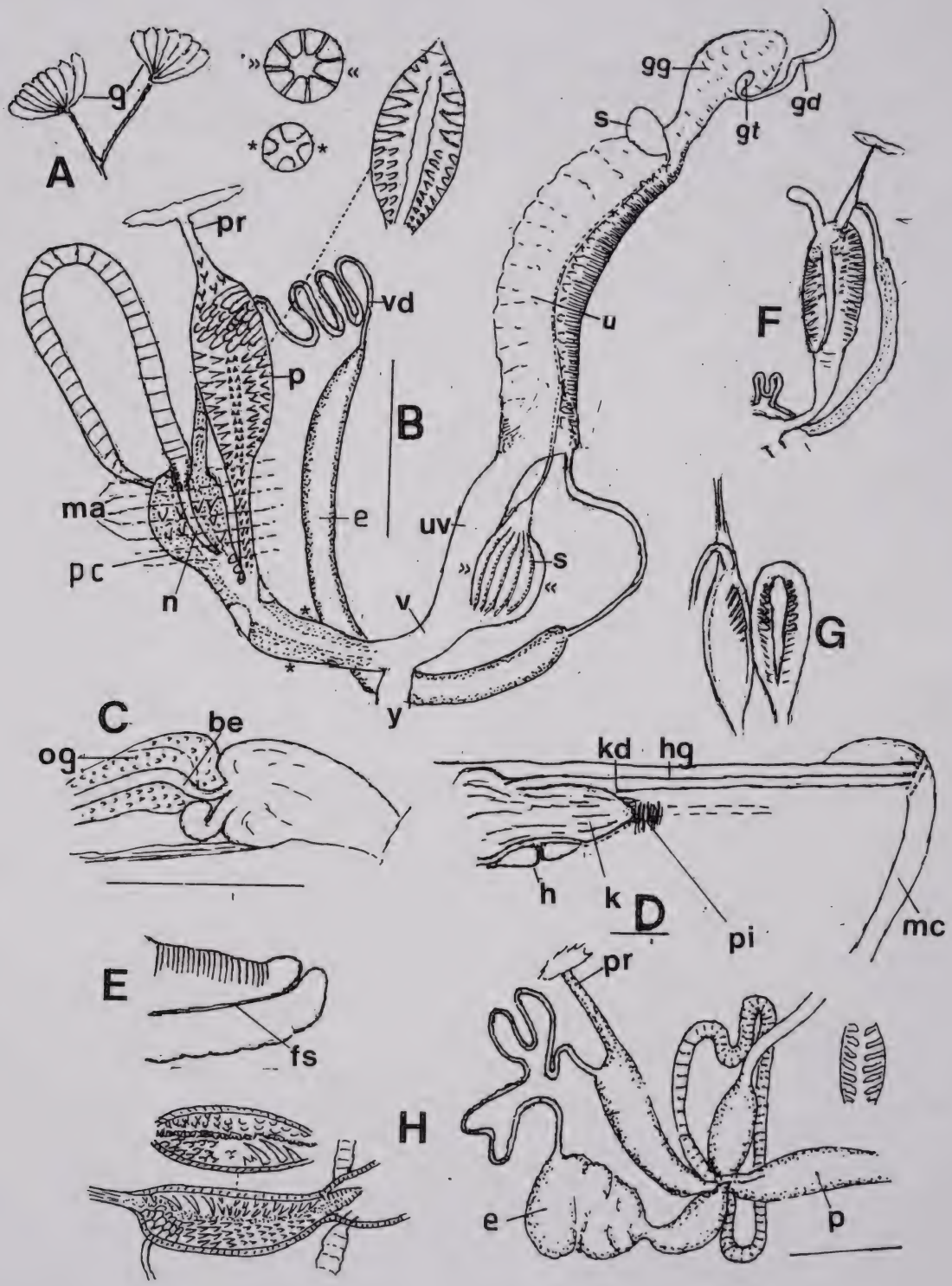
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Table 9. Structural features of the shell of *Phenacohelix tholoides* (Suter, 1907) based on measurements taken from representative shells of adults from selected localities. Shell parameters: 1 = width; 2 = height; 3 = whorls; 4 = protoconch width; 5 = last whorl width; 6 = umbilicus width; 7 = number of ribs on 1st teleconch whorl; 8 = number of ribs on last teleconch whorl.

Locality		Shell parameters							
		1	2	3	4	5	6	7	8
1	Waitanoni	3.8	3.0	4.1	1.0	1.0	0.2	48	77
2	Mahurangi Pt.	4.1	3.1	4.5	1.1	1.0	0.2	47	80
3	Surville Cliffs	4.8	3.6	5.0	1.3	1.2	0.0	55	149
4	Surville Cliffs	4.6	3.4	4.8	1.1	1.2	0.2	57	144
5	Tapotupotu	3.1	2.3	4.0	1.1	1.6	0.0	45	70
6	Whangaroa	5.1	3.7	5.0	1.0	1.0	0.3	45	97
7	Ngahau Bay	4.5	3.1	4.8	1.0	1.2	0.1	45	83
8	Ngahau Bay	4.5	3.1						
9	Ngahau Bay	4.4	3.0	4.8	1.0	1.1	0.1	49	100
10	Whananaki	4.7	3.4	4.8	1.1	1.2	0.2	47	99

2. AK155650. 3, 4. AK155649. 7. AK152179. 8, 9. AK154067. 10. AK154041. All F.J. Brook. 1. AK154354, P.M. 5. AK155598, J.G. & P.M. 6. AK155371, B.F. Hazelwood.

Is. M02 792469, F.J. Brook & J. McCallum 11/6/88, AK91771. **Tokerau Beach** O03. A Richardson, AK83215; O04 467939, F.J. Brook 5/11/87, AK95453; O04 467938, F.J. Brook 18/8/94, AK95445. **Te Ruatahi** Q06 407371, F.J. Brook 7/12/93, AK85548; Q06 404372, F.J. Brook & J.F. Goulstone 17/4/94, AK85065.

RECENT: Te Paki, Herangi M02 799479, F.J. Brook 1/1/94, AK100003; M02 803471 60 m, F.J. Brook 8/12/94, AK-L11995. **Te Werahi** M02 812478, F.J. Brook 5/5/96, AK151934; M02 812478, F.J. Brook 5/5/96, AK-L20760. **Cape Maria van Diemen** M02, N. Douglas 26/5/71, AK152057; L. Fitzgerald, AK83213; M02 787474, F.J. Brook 30/9/95, AK-L17788, AK-L17789. **Cape Reinga** A.W.B. Powell, AK83365. **Tapotupotu** M02 838511, 7/2/67, AK83214; M02 839511, L. Price 22/7/81, AK153504; M02 851515, D. Hole 7/1/75, AK154111; M02 852515 5 m, J.F. Goulstone 11/5/91, AK-L10450; M02 851517 5 m, J.F. Goulstone 18/11/98, AK155595; M02 840509 40 m, J.F. Goulstone & P.C. Mayhill 16/11/98, AK155598; M02 838512, B.F. Hazelwood & J. Marston 5/6/96, AK-L20763. **Pandora** M02 908408, J.F. Goulstone 12/5/91, AK96194; M02 891478, J.F. Goulstone 11/5/91, AK-L8940. **Kauri Bush** M02 895476 260 m, P.C. Mayhill 1/11/97, AK154368; M02 894477 130 m, J.F. Goulstone & P.C. Mayhill 18/11/98, AK155612, AK155614; A.W.B. Powell, 1/1/48, AK83240. **Kohuronaki** N02 958461, N. Douglas 17/10/74, AK151620; N02 967448 40 m, J.F. Goulstone & P.C. Mayhill 17/11/98, AK155609; N02, N. Douglas 2/6/69, AK-L2192. **Spirits Bay** N02, N. Gardner 27/12/47, AK83242; N02 989526, D. Hole 2/1/75, AK154091. **Waterfall Gully** N02, C. Barker 1965, AK83237, AK83241. **Maungapiko** N02 983534, J.F. Goulstone 11/5/91, AK83210. **Waitanoni Valley** N02 998525 130 m, P.C. Mayhill 1/11/97, AK154354. **Te Hapua Rd.** N02 997449 30 m, J.F. Goulstone & P.C. Mayhill 17/11/98, AK155602; N02, N. Douglas 13/5/73, AK83212, 25/5/71, AK154340. **Unuwhao** N02 274 m, A.W.B. Powell 1/2/32, AK25439. **Waihi Stream** N02 005527, J.F. Goulstone 10/5/91, AK83209. **North Cape Block** 30/4/68, AK83239; **Mahurangi Pt.** N02 102544 20 m, F.J. Brook 11/12/98, AK155650. **Surville Cliffs** N02 120562 200 m, F.J. Brook 11/12/98, AK155649. **Kerr Pt.** N02, 1/1/52, AK83216, A.W.B. Powell 23/3/49, AK83238. **Karikari Bay** O03 463065, N. Douglas 28/5/69, AK152095, AK152096. **Whakaangi** O04 616944 335 m, L. Price 1/1/60, AK153502. **Paranui Scenic Reserve** O04 513814 40 m, P.C. Mayhill 1/4/83, AK154854. **Whangaroa** P04 788826, B.F. Hazelwood 24/5/98, AK155210; P04, C. Cooper 1930, AK26071; P04, A. Hamilton, AK64142. **Coppermine Rd.** P04 770757 80 m, P.C. Mayhill 1/10/84, AK154697. **Te Whau** P04 912721; N. Douglas 6/6/69, AK152110. **Matauri Bay** P04 944841, N. Douglas 17/11/70, AK152130; P04 934843,

B.F. Hazelwood 29/8/98, AK-L21911. **Tauranga Bay Stream** P04 834870, D. Hole 9/1/75, AK154112. **Te Ngaire** P04 912856 80 m, P.C. Mayhill 1/11/88, AK154881; P04 913856, B.F. Hazelwood 24/5/98, L21824, AK-L21904. **St. Pauls Rock Reserve** P04 795832, B.F. Hazelwood 28/8/98, AK155371. **Mangataipo Rd.** O05 592622 40 m, P.C. Mayhill 1/3/96, AK154901. **Bland Bay** Q05 344466 20 m, P.C. Mayhill 1/5/78, AK154926. **Moanarua Is.** Q05 357497, F.J. Brook 13/3/96, AK-L20709. **Moturoa Is.** Q05 104648 10 m, P.C. Mayhill 1/1/90, AK154856. **Mimiwhangata** Q06 397367, F.J. Brook & J.F. Goulstone 10/12/93, AK83211; Q06 375370, F.J. Brook & J.F. Goulstone 22/4/94, AK85190; Q06 399398, F.J. Brook & J.F. Goulstone 18/4/94, AK85338, AK85201, AK85504. **Ngahau Bay** Q06 373392, F.J. Brook 22/6/94, AK152179, AK154067, F.J. Brook & J.F. Goulstone 19/9/94, AK154067, F.J. Brook & J.G 19/4/94, AK85574. **Te Ruatahi Is.** Q06 408371, F.J. Brook & J.F. Goulstone 7/12/93, AK85597. **Helena Bay** Q06 343398, F.J. Brook 18/6/94, AK89191; Q06 349393, F.J. Brook 14/5/94, AK89280; Q06 356395, F.J. Brook 15/5/94, AK89371, Q06 349393, F.J. Brook 14/5/94, AK-L10354. **Whananaki** Q06 444309, F.J. Brook 20/9/94, AK154041.

DISTRIBUTION AND HABITAT

Phenacohelix tholoides ranges from Te Paki in the Far North to Whananaki, just north of Whangarei, with a mainly eastern distribution. Although *P. tholoides* is found at inland sites, it is more prominent near the sea where it may be found in a wide range of litter types, such as that of pohutukawa (*Metrosideros excelsa*), flax, *Pseudopanax* sp., and mahoe (*Melicytus ramiflorus*). It also lives under rotting logs and in fallen nikau fronds.

Phenacohelix ziczag (Gould, 1846), new combination

Figs 11, 12

DESCRIPTION

External Morphology

Foot white, its margin crenellated and surmounted by two pedal grooves. Dorsal surface of foot grey, crinkled.

Reproductive Anatomy

Ovotestis comprises two clumps of finger-like alveoli (0.6 mm wide). Hermaphrodite duct initially slender but gradually becomes distended as medial seminal vesicle, then abruptly narrows to terminate in carrefour embedded within the albumen gland. Talon not observed. Albumen gland (up to 4 mm x 2 mm) ovoid. Spermoviduct 5 mm long, narrow where it joins albumen gland (0.3 mm) but expands three-fold or more to form ovoid organ dominated by oviductal glands but with prominent band of prostatic alveoli visible along its entire length. Free oviduct variable in width (0.2-0.4 mm), 1.6 mm long. Spermathecal duct with a prominent, bulbous swelling (1.5 mm long) immediately above its opening to the vagina, with narrow lumen, then abruptly forming a slender duct terminating in an oval sac (1.1 mm long) resting against the albumen gland. Vagina generally long (1.4 mm), tubular, uniformly wide throughout (0.3 mm). Vas deferens slender throughout, terminating in apex of the penis adjacent to the penial retractor muscle. Epiphallus not observed. Retractor muscle rising from diaphragm close to the base of the kidney. Penis (3.8 mm long) somewhat variable in shape but generally comprising three proximal chambers and a distal tubular connection to the atrium. The most proximal chamber is elongate (1.4 mm long), equipped internally with small, spinate papillae in sexually immature animals, these reducing in mature animals and lumen becoming dominated by longitudinal folds. The second and third proximal chambers, each increasingly larger, tend to be bulbous, equipped internally with both small, and very large, spinate papillae in immature

animals, and predominately with ridges and folds in mature animals. The third chamber bears a prominent lateral, sacculate caecum. In immature animals the caecum is equipped with one or two solid darts, anchored on the farthest wall and projecting towards the penial lumen, and two tubular glands evidently opening to the penis, in addition to numerous minute papillae. In older specimens the darts are frequently absent and the glands often somewhat degenerate.

Other Anatomy

Pallial cavity 10 mm long, with little pigmentation on upper membrane. Mantle collar 3.5 mm wide. Kidney (4.2 mm long) has strong pericardial lobe with heart (1.5 mm long) recessed in outer wall, and small, rounded rectal lobe. Ureter skirts along anterior face of the pericardial lobe from its apex to junction with renal lobe, then turns forward adjacent to hindgut to open through respiratory pore slightly behind anus. Reflexed arms of ureter well separated. Oesophagus, with flanking salivary gland ducts, enters dorsal-posterior aspect of the buccal mass. Salivary glands occupy considerable space surrounding oesophagus immediately in rear of buccal mass.

REMARKS

Six specimens of *Phenacohelix ziczag* were dissected (Table 10). I have figured the considerable progression of characters in the penis lumen between young and old specimens of *P. ziczag*. The size of the shell in this species, as is the case in *P. tholoides*, is not a good indicator of stage in sexual development. The darts and spinate papillae of the young specimens are replicas of those found in *P. tholoides* and *P. giveni*, but in the present species the darts are evidently not permanent fixtures and the papillae tend to be replaced with ridges and channels in older specimens. The oldest specimen dissected (ex Waipoua Forest) had a small dart, suggesting that darts lost during sexual activity are replaced. This individual also had a yellow-orange spermatophore lodged in the base of the spermathecal duct, indicating that the epiphallus is present, albeit not sufficiently differentiated from the vas deferens to be apparent in dissections. The penial caecum is equipped with paired, tubular glands. In one dissection, these glands were considerably reduced, with the caecum containing indeterminate solid matter. This suggests considerable dynamism in the condition of the secretory activity.

DISTRIBUTION AND HABITAT

Phenacohelix ziczag occupies the northern part of the North Island except the Far North at Te Paki. It lives in all kinds of litter, and can tolerate coastal situations with much sea spray. I have found it occasionally with *P. giveni* in nikau fronds or under logs or bark. It also tucks into rock or wood crevices.

Fig. 11 (opposite). Anatomy of *Phenacohelix ziczag* n. comb. Scale lines = 0.5 mm (B) or 1 mm (A, C-I). A-D. AK-L21719, Waipoua Forest. E. AK155160, Hakarimata Ra. F. AK155158, Lake Tarawera. G. AK154570, Albany. H. AK154568, Waipipi Sc. Res. I. AK154570, Albany. A. Reproductive organs. B. Ovotestis. C. Posterior portion of foot. D. Pallial organs, ventral view. E. Younger specimen than B. F. Large specimen without tubes or needles in penial epiphallus. G. Young specimen with penis lumen just developing. H. Penis lumen from a fairly well developed shell just prior to penial epiphallus developing. I. Reproductive organs from shell slightly larger than that of H, with developing epiphallus but containing only one large needle. For key to abbreviations, see Fig. 1.

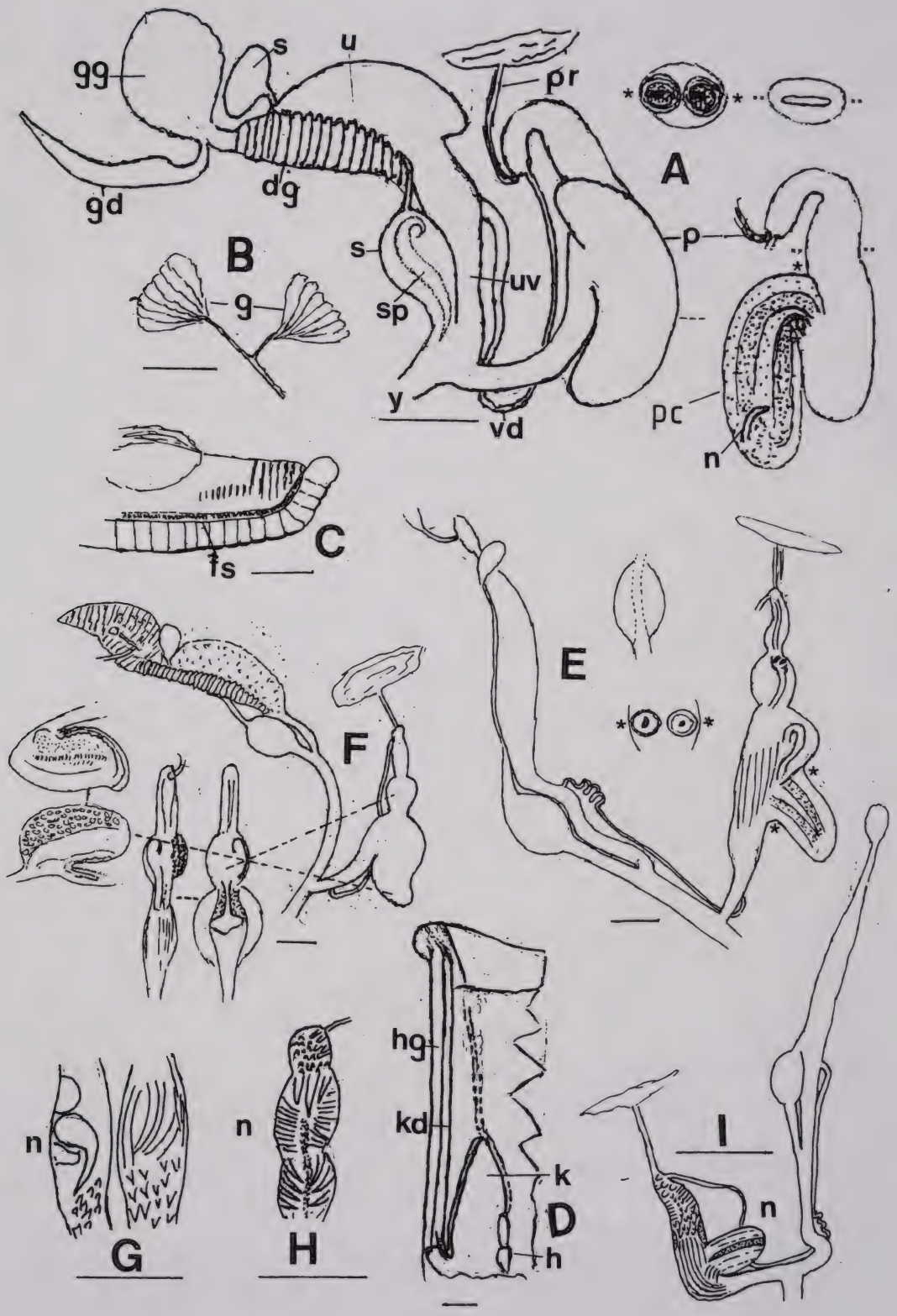
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Table 10. Structural features of the shell of *Phenacohelix ziczag* (Gould, 1846) based on measurements taken from representative shells of adults from selected localities. Shell parameters: 1 = width; 2 = height; 3 = whorls; 4 = protoconch width; 5 = last whorl width; 6 = umbilicus width; 7 = number of ribs on 1st teleconch whorl; 8 = number of ribs on last teleconch whorl.

Locality		Shell parameters							
		1	2	3	4	5	6	7	8
1	Waipoua Forest	9.5	5.5	5.8	1.3	2.7	2.0	49	81
2	Albany	7.7	4.6	4.8	1.3	2.2	1.2	30	64
3	Albany	7.5	4.5	4.5	1.3	2.2	1.2	30	65
4	Waipipi Sc. Res.	6.9	4.1	4.5	1.3	2.4	1.3	26	54
5	Hakarimata Ra.	8.9	5.3	5.2	1.4	3.0	1.1	42	80
5	Hakarimata Ra.	8.4	5.6	5.0	1.3	2.9	1.1	36	85

1. AK-L21719, O06 623165 G.M. Barker 1/7/91. 2, 3. AK154570, R10 592974 100 m, J.F. Goulstone 17/10/97. 4. AK154568, R12 580412, J.F. Goulstone 30/12/97. 5. AK155160, 38°50'S 175°7.5'E, G.M. Barker 29/12/91. 6. AK155158, 38°11'S 176°26'E, G.M. Barker 1/1/80.

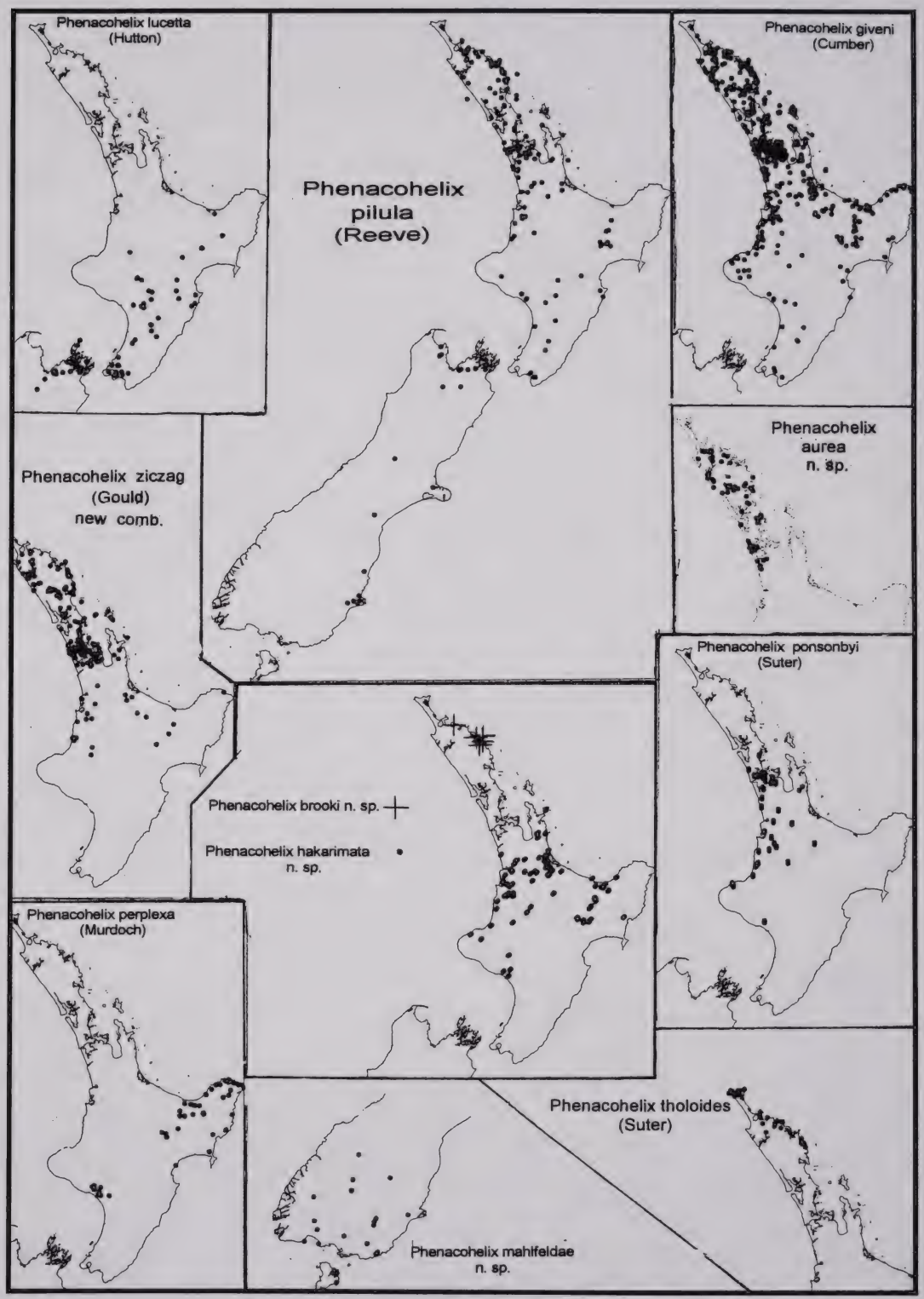
DISCUSSION

From an anatomical point of view *P. pilula* and *P. ponsonbyi* are very similar, both having the tubular penial caecum. *P. giveni* and *P. tholoides* have a more complex penial caecum containing a substantial section with spinate papillae and a large hollow dart connected to a tubular gland. The structure is basically similar in *P. ziczag*, except that the dart and glands are primarily paired and the gland is housed inside the caecum rather than external. These five species also have similar shell features. Having similar shell features to all the foregoing, but with a poorly developed penial caeca are *P. hakarimata* n. sp., *P. perplexa*, *P. aurea* n. sp., *P. brooki* n. sp. and *P. mahlfeldi* n. sp. In *P. lucetta* the penial caecum is evidently strongly reduced. Thus the dissected species form a gradient from the condition in which the male genitalia are equipped with dart(s) and associated gland(s) through to that in which these structures are vestigial. In the absence of a clear 'break point' in this gradient, I have retained all these dissected species within the genus *Phenacohelix*. This is the first observation of complex, dart-bearing stimulatory organs in the family Charopidae.

Live *Phenacohelix* are often plentiful, but populations are frequently dominated by immature specimens and it is often difficult to find specimens in the upper quartile of the shell size range for the species. Further, shell size or shell whorl number is often a poor indicator of the sexual maturity of the animal. That is, a shell of mature appearance may contain an animal with underdeveloped genitalia. It would be desirable to examine a series to ascertain the extent of variation among individuals and the extent to which reproductive features change with age.

Acknowledgements: I am very much indebted to those people who have collected live snails for me, namely Gary M. Barker, Fred J. Brook, Bruce F. Hazelwood and Pauline C. Mayhill. Mrs Mayhill has also donated to the Auckland Museum *Phenacohelix* shells of all species from many localities. Frank M. Climo and Karin Mahlfeld of Wellington have been helpful in many ways. The staff of the Auckland Museum marine section (Ramola Prasad, Glenys Stace and Maree Johnson) have been supportive.

Fig. 12 (opposite). Distribution maps for the species of *Phenacohelix* discussed in this paper, compiled from records of specimens in the Auckland Museum collection.


Phenacohelix lucetta
(Hutton)
Phenacohelix
pilula
(Reeve)
Phenacohelix giveni
(Cumber)
Phenacohelix
aurea
n. sp.
Phenacohelix ziczag
(Gould)
new comb.
Phenacohelix ponsonbyi
(Suter)
Phenacohelix brooki n. sp.
Phenacohelix hakarimata
n. sp.
Phenacohelix perplexa
(Murdoch)
Phenacohelix tholoides
(Suter)
Phenacohelix mahlfeldae
n. sp.

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[The manuscript for this paper was submitted on 2 June 1999. Sadly, Jim Goulstone died later the same year. I thank Gary Barker and Fred Brook for their assistance in preparing the manuscript for publication—*Editor.*]

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